Antimicrobial bio-film from rosemary

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INTRODUCTION

Our world has always had a need to preserve goods. The idea of better protection and preservation of goods has led to the development of plastic packaging.However, it is not always recycled, nor is it perfectly safe to use. Therefore, as is well known, plastic plays a major role in environmental pollution and may even pose health risks to consumers. Organic compounds require a much smaller period of time for biodegradation and therefore can be a perfect replacement. Plastic, as previously mentioned can also be harmful to consumers as they contain toxins. However, using organic alternatives could also solve this problem as well.

The aim of our project is to create a bio – plastic that accomplishes the goals of being environmentally friendly and being safe to use for consumers. Our project more specifically is aimed at the production of bioplastic for food storage. Therefore, we emphasize the consumer purposes inasmuch so that we aim to give our product antimicrobial properties, which would certainly be a very useful quality in food packaging.

THEORETICAL PART

The base product of our bio – film (bioplastic) is starch. Starch is an organic compound, more specifically a polymeric carbohydrate. It is constituted of semi-crystalline granules, composed of two polymers of glucose, called amylose and amylopectin. It is an inexpensive, readily-available material. On the basis of biodegradability, availability, renewability, non-toxicity, and affordability, starch is one of the most promising of all the potential biopolymer materials. The use of starch in packaging promotes sustainability and addresses the negative impact non-biodegradable plastics pose on theenvironment. Starch has a very important property; in that it can be gelatinized. This irreversibly dissolves the starch granule in water. Water acts as a plasticizer. Gelatinized starch, when cooled for a long enough period (hours or days), will thicken (or gel) and rearrange itself again to a more crystalline structure in a process called retrogradation. Basically, with retrogradation the dissolved starch granules crystallize and form a stiff gel. This concept is the core of our product upon which we build upon.In the creation of our bio – plastic we also use sorbitol and glycerol as plasticizers. It is also necessary to mention that the gelatinization temperature of starch depends upon plant type and the amount of water present, pH, types and concentration of salt, sugar, fat and protein in the recipe, as well as starch derivatization technology are used. An integral part of our project is introducing antimicrobial properties to our bio – film. For our film to attain antimicrobial properties, we use rosemary. Salvia rosmarinus, commonly known as rosemary, is a woody, perennial herb with fragrant, evergreen, needle-like leaves and white, pink, purple, or blue flowers, native to the Mediterranean region. It has been proven to exhibit antimicrobial properties. Various studies have shown the antibacterial activity of rosemary oil against E. coli, Bacillus cereus, Salmonella choleraesuis, Staphylococcus and other bacteria. The inhibitory effect of rosemary is the result of the action of rosmarinic acid, rosmaridiphenol, carnosol, epirosmanol, carnosic acid, rosmanol and isorosmanol.

PROCEDURE

Firstly, starch is placed in an aqueous solution. Minced rosemary leaves along with acetic acid are then added and the entire mixture is heated. The acetylation of starch is then catalyzed by the addition of sodium hydroxide. When this mixture reaches a high enough temperature, as a final ingredient sorbitol is added acting as a plasticizer. Once the mixture becomes viscous it is taken out of its container and placed on a surface where it proceeds to cool and harden, leading to the desired bio-film. Multiple bio-films with different proportions of ingredients were also produced to determine the optimal amount of the ingredients needed to achieve the best results. In half the cases, glycerol was used as a replacement for sorbitol.

MATERIALS AND METHODS

MATERIALS

The materials used for the creation of a single bio-film are listed below:

·Minced rosemary leaves 5 mg

·Starch

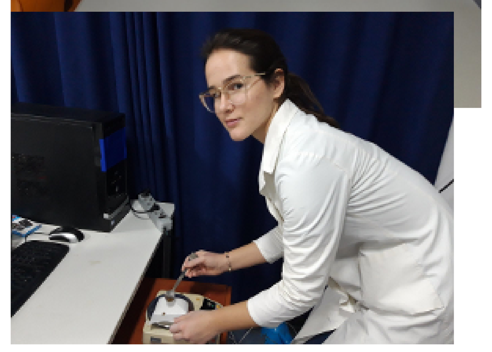
·Water 30 ml

·Sodium hydroxide (NaOH) 4 ml

·Sorbitol 4 ml / Glycerol 4 ml

·Acetic acid (CH_3COOH) 10 ml

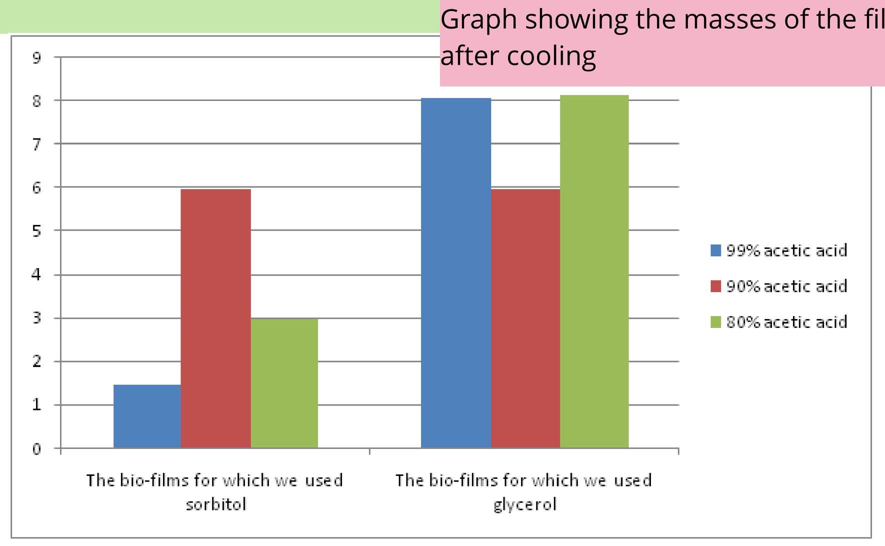
·BeakerButane gas Bunsen



METHODS

Starch is placed in a beaker seated atop a butane gas Bunsen burner. 20 ml of water along with 10 ml of acetic acid (CH_3COOH) and 5 mg minced rosemary leaves are added to the beaker. The Bunsen burner is turned on heating the contents in the beaker. 4 ml of sodium hydroxide (NaOH) are then also added to the mixture as well as 4 ml of sorbitol afterwards. The mixture is stirred until it becomes viscous. This should occur when the temperature is between 55 °C and 85 °C. When this happens, the mixture is extracted from the beaker and laid out to cool and harden at room temperature. A total of six bio-films were created using different proportions of some ingredients while the rest remained the same. In three cases sorbitol was replaced with glycerol. The first bio-film was created with 20 g of starch and 90 ml of water using a 99% acetic acid concentration. The second was produced with 5 g of starch and 30 ml water using a 90% acetic acid concentration. The third bio-film was produced with 5 g of starch, 30 ml of water and 5 ml of sorbitol using an 80% acetic acid concentration. The additional three bio-films were created in a similar manner; every one of these bio-films used the same proportion of ingredients as the previous bio-films however, in these cases the sorbitol was replaced with glycerol.

Graph showing the masses of the films after cooling

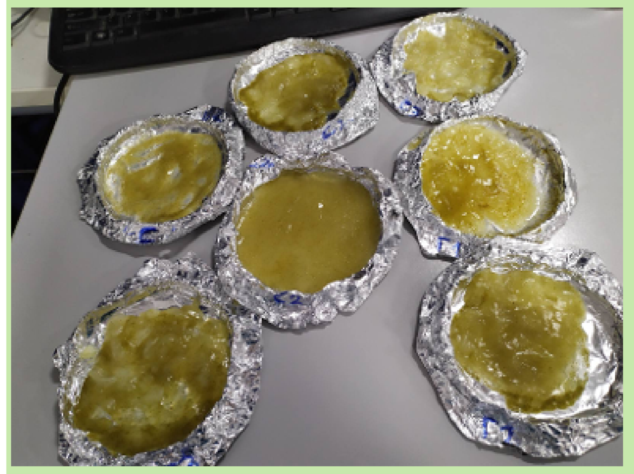


RESULTS

A) The three films we obtained using ***glycerol*** show the expected and wanted physical and chemical properties. The properties are listed below:***Acetic acid 99% Bio -Film:*** This bio film shows total flexibility, similar to a plastic bag. Although it is flexible, it is resistant and can withstand a large pressure and force. Mass: 8,06 g. ***Acetic acid 90% Bio – Film:*** This bio film is also extremely flexible, resembling plastic. Its texture is softer than the one of plastic, but it is tough and can endure a fair amount of force and pressure. Mass: 5,97 g. **Acetic acid 80% Bio – Film**: Even with a lower concentration of acetic acid it still displays useful qualities such as the previous ones. It is still flexible, although slightly less than the other 2 films produced with glycerol. Mass: 8,14 g

B) The properties of the three films obtained with ***sorbitol*** are listed below: ***Acetic acid 99% Bio -Film***: The first film with the highest concentration of acetic acid is tough, but less flexible than the ones with glycerol. Mass: 1,46 g. ***Acetic acid 90% Bio – Film***:This film shows a bit smaller flexibility than the ones with glycerol, but we firmly recommend it for packaging. This film mimics some harder plastic types. Mass: 5,57 g. **Acetic acid 80% Bio – Film**: This film is similar to the ones made with glycerol. It is really flexible and endurable. Mass: 2,96 g

Bio-films before cooling



Bio-films after cooling





DISCUSSION

We conclude that the higher concentration of acetic acid makes the glycerol films more flexible, with great texture which is convenient for fragile and delicate items, as well as bigger every day products. The trend seen with the films using sorbitol is the opposite of the one seen using glycerol. Namely, here the films produced with acetic acid with smaller concentration are more flexible. The films made with glycerol are generally more flexible, while the ones made with sorbitol are firmer, holding more similarities to common plastic. It is also important to again mention that all of these bio – films contain the proven antimicrobial herb, rosemary.

CONCLUSION

The use of bioplastics is essential, as it plays a fundamental role in controlling the interactions between food and the environment, protecting and maintaining product quality, beyond its basic function of containing food. However, the polymers used in this industry are made from non-renewable synthetic materials, which, despite having excellent functional properties, are causing serious environmental problems due to the generation of high amounts of non-biodegradable solid waste in the environment.