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Kampus Sungai Petani

Faculty of Administrative  
Science and Policy Studies

# i-SPIKE 2021

*Leading An Artificial Innovation In Knowledge, Education And Design*

## **i-SPIKE 2021 INTERNATIONAL EXHIBITION & SYMPOSIUM E-PROCEEDINGS**

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## CORN-BASED BIOPLASTIC AS SEEDLING BAG

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### ABSTRACT

Polyethylene bags have traditionally been used in the production of seedling bags, which are discarded in the soil or burned after transplantation due to the enormous amount of organic material connected to the bags, which is impossible to recycle or decompose. Furthermore, when a seedling is removed from its bag for transplant, there is a potential of root damage, which directly impacts the plant's growth. In this study, seedling bags that made from corn starch with filler (diammonium phosphate or potassium nitrate) to be used in plant seedling. Corn-based bioplastic offers a seedling bag that can be planted directly into the soil, do not required to transplant the plant, decompose naturally and also supply nutrients to plants. Which is it will reduce the risk of root damage and encouraging the plant's growth. Due to increasing public awareness around the world have opened up new market opportunities. Besides, with a similar feature with polyethylene bag, it's an ideal alternative in the sense of environmental sustainability and also compatibility.

**Keywords:** bioplastic, starch-based, corn starch, filler, seedling bag

### INTRODUCTION

Polyethylene bags are commonly used in agriculture for seedling production. There hasn't been much research done on how to dispose of these bags or what happens to them once they've been used as plant seedlings. Most of the plastic waste used in agriculture is either buried in the soil which will causing permanent pollution or incinerated and then releasing hazardous pollutants into the air (Bilck et al.). This is because of an expensive labor expense as well as the lack of a cost-effective disposal mechanism. Other than that, polyethylene bag is hard to recycle and decomposed due to the high amount of organic matter that adheres to the material.

Due to increasing public awareness, this is where the bioplastic was introduced. Bioplastic can be biomass or bio-based or both depending on raw material used according to European Bioplastic. The focus of recent research has shifted to starch-based bioplastics. Starch based plastic are usually from rice, wheat, corn and potatoes. Corn starch is the cheapest and most used for starch-based plastic. However, because of their hydrophilic nature, this type of plastics faces the several drawbacks which is weak mechanical, thermal, and water vapor barrier properties when compared to synthetic composites, which limits the functions and their applications.

Nonetheless, to overcome those drawbacks, a filler was added into corn-based bioplastic to improve their properties. Diammonium phosphate and potassium nitrate was used as filler.

Diammonium phosphate and potassium nitrate were chosen as fillers not only to improve the corn-based bioplastic qualities, but also to provide nutrients to plants and encourage plant growth because diammonium phosphate and potassium nitrate are commonly used soil fertilizers (Abdul Khalil et al.).

Corn-based bioplastic as seedling bag offers a seedling bag that can be planted directly into the soil, needless transplant the seedling, decompose naturally and supply nutrients to plants. Which is it will reduce the risk of root damage and encouraging the plant's growth.

### Usefulness

One of the major advantages of this corn-based bioplastic as seedling bag, it will decomposes naturally and then led to the reduction of non-biodegradable waste that pollutes the environment. Second, when using this corn-based bioplastic as seedling bag, this bag can directly plant into the soil without damaging the plant's root and also promoting plant development. Next, this seedling bag used renewable resources eventually reduce carbon footprint, significantly lower source and minimum electricity during manufacturing. Also, this seedling bag does not contain harmful chemicals and safe for human and environment.

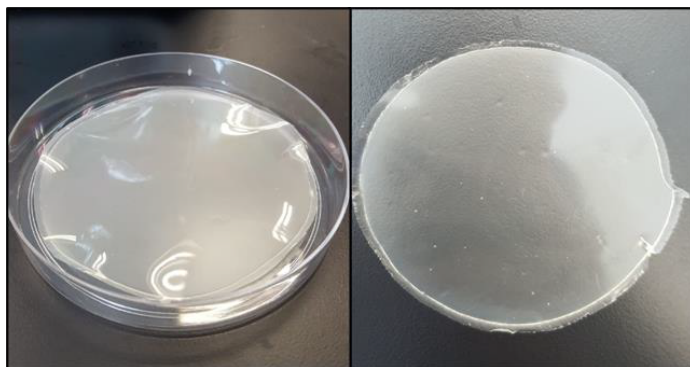
### Novelty

Current biodegradable seedling bag are made from non-woven material however this seedling bag is from starch-based material. This seedling bag is made from corn which means it can directly plant and decompose naturally in soil, without transplant the bag without damaging the root and compromise the plant's growth. Also, additional of diammonium phosphate and potassium nitrate as filler to enhance corn-based bioplastic (seedling bag) properties and supply nutrients to soil and also plants.

## METHODOLOGY

The corn-based bioplastic solution was prepared by mixing 100 ml of distilled water and (20 % w/w of distilled water) corn starch. Then, the glycerol (40 % w/v of starch) was added as a plasticizer and lastly, 5 cm<sup>3</sup> of acetic acid with 5% acidity was poured into the solution. After that, the filler (25 % from total corn starch) was added into the solution. There are 2 fillers used in this product which is diammonium phosphate and potassium nitrate. The film solution was heated to 75 °C under constant stirring using a magnetic stirrer with a stirring speed of 300 rpm to 90 rpm to obtain starch gelatinization and continue to stir manually until the solution becomes viscous and transparent. After that, the solution was poured into the petri dish which acts as a casting plate and dried in the air-conditioned room (25±1 °C) for 72 hours (to ensure the film was dried) on the flat surface (to ensure the film thickness was consistent). Before that, the film undergoes pre-drying process in the oven for 2 hours. The drying process was using a solvent casting method. The solvent casting method is practical, preferable and widely used due to its simple process. Figure 1. show the corn-based bioplastic after a drying process.





**Figure 1.** Corn-based Bioplastic

Characterization: Mechanical properties

By using Universal Testing Machine, the tensile strength (TS) and elongation at break (EAB) were determined. Each sample and method were prepared based on standard test method for tensile properties of thin plastic sheeting which is ASTM D882. Each sample were cut into 100 mm × 15 mm with initial separation length of 60 mm and crosshead speed 0.5 mm/sec.

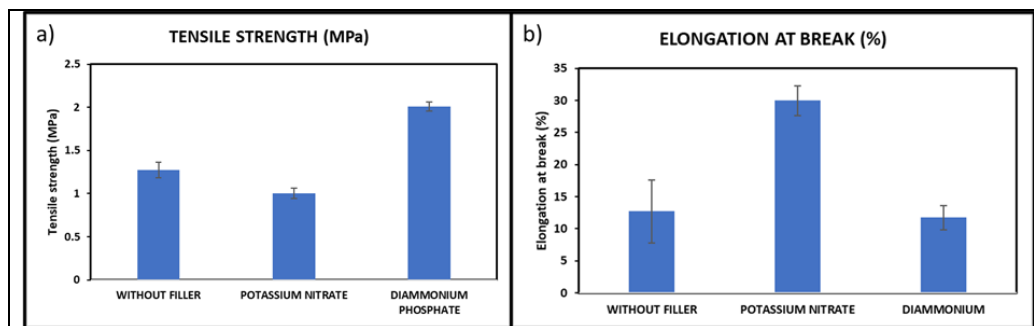
Characterization: Moisture content

The film was weighed before the film goes into the oven (weight before) and the film left in the oven for 24 hours or until getting the constant weight at 50°C (weight after). The moisture content in the film was calculated using the following equation:

$$\text{Moisture content (\%)} = ((\text{Weight Before} - \text{Weight After}) / \text{Weight Before}) \times 100\%$$

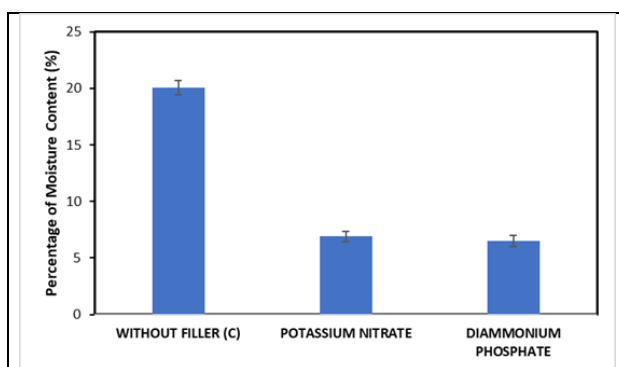
## RESULT & DISCUSSION

From the Figure 2, when compared to corn-based bioplastic without filler, addition of diammonium phosphate filler has increase the tensile strength value but lack of flexibility but potassium nitrate filler has an adverse result. This is due to diammonium phosphate filler has higher surface area compared to potassium nitrate filler which is resulting the diammonium phosphate filler to be more effective in transferring the stress or surface tension from the matrix to the filler (Abdul Khalil et al.).



**Figure 2.** a) Tensile strength and b) Elongation at break

Moisture is one of the most important factors affecting the properties of starch-based films. From the Figure 3, addition of DP and PN filler into the matrix has greatly reduce the percentage of moisture content of corn-based bioplastic (6.49 % and 6.89 % respectively) compared to film without filler (20.09%). The is because of the filler acts as a discontinuous phase in the composite, dispersed and disseminated throughout the matrix (Jiawei Ren et al.). Jiawei et al. also report same finding which is addition of filler greatly reduces the percentage of moisture content.



**Figure 3.** Moisture Content

## CONCLUSION

From the result, can be seen that addition of filler are needed to maximize the corn-based bioplastic properties. An increasing knowledge of the climate around the world have opened up new market opportunities. Besides, with a similar feature with polyethylene bag for seedling production, it's an ideal alternative in the sense of environmental sustainability and also compatibility.

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