A growth towards sustainability-PLANTEN

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ABSTRACT

Disposable pens often use an unnecessary amount of plastic and usually use both metal and plastic as making them very difficult to recycle. Add the rest of the world multiply by over 50 years of writing with disposable pens, and that and plastic waste ending up in a landfill. Conventional pens are often mass produced with non –recyclable, petroleum-based materials, filled with inks that contain toxic chemicals and blister- packed in non – recyclable PVC packaging.

Biodegradable plastic is plastic that decomposes naturally in the environment. This is achieved when microorganisms in the environment metabolize and break down the structure of biodegradable plastic. Biodegradable plastics are made from all-natural plant materials. These can include corn oil, orange peels, starch, and plants.It in decompose naturally in the microorganisms in the environment metabolize and breakdown the structure of biodegradable plastic. The end result is one which is less harmful to the environment than traditional plastic.

Keywords : ldpe, degradation, environment, biodegradable.

1. INTRODUCTION

High – Density Polyethylene (HDPE) is a thermoplastic polymer produced from the monomer ethylene. HDPE can range from 930 to 970 kg/m^3 .It is also harder and more opaque and can withstand somewhat high temperature (120^0 C/248^0C). Their strong and durable nature doesn't however, convert into inert biomass through the process of biodegradation. This plastic can persist for hundreds of year, which can contribute to the growt of phlastic. Low – Density Polyethylene (LDPE) is a thermoplastic made from monomer ethylene. LDPE is defined by a density range of 0.917 – 0.930g/m^3. It can withstand a temperature of 80^0C continuously and 90^0C (194^0F) for a short time made in translucent or opaque variations, it is quite flexible and tough. Innovation and advancement in Engineering and Technology have resulted in a tremendous increase in the demands, production consumption and generation of polyethylene wastes. Non–biodegradability of polyethylene wastes had imposed serious to animals, birds who often mistaken them for prey, and are consequently shocked to death due to the non-degradability of the polymer.

Corn-starch which is a polysaccharide consisting of a large no. of glucose units linked by the glycoside bonds are rich in amyl pectin chains. The amyl pectin is a polymer molecule with branching occurring at the (1-6) glucosidal bonds. It has the tendency to form hydrogen bonds with another polymer chain, and as a result impact affinity towards water molecules due to the presence of many end points for enzymatic attack. Corn-starch consist of high amyl pectin molecules, had been considered in this research as suitable material due to its inherent biodegradability, sustainability, low cost, non-toxic any easy of ability properties. Starch-rich in amyl pectin had been reported to be higher in flexibility, elongation at break points, but exhibit lower tensile strength (Walenta, et al 2001). Aamer, et al (2003) has reported that low-density polyethylene can be modified to adjust their pH range, polymer structure, the percentage of crystalline, water content and geometry of plastic chains to affect their biodegradation. Shahzad (2012) reported that erosion observed the surface of starch polyolefin blends were evidence of starch removal by a starch loving microorganism which could initiate the biodegradation process. As our contribution to make a pen from biodegradable plastic instead of non-biodegradable HDPE.

2. EXPERIMENT

2.1. MATERIAL AND EXPERIMENT

In the 1st phase of the experiment, five types of LDPE polymer samples were produced in combination with various percentages of starch. Low-density polyethylene (LDPE) and sago starch (Igan Sago Industries Sdn. Bhd.) were weighed by a top loader balance (AND, model GF-3000) with various percentages of LDPE and starch (Table 1).

Table 1: Relative percentage of LDPE and starch of polymer samples.

Sample ID	% LDPE	% Starch
LDPE00-Starch0	100	0
LDPE90-Starch10	90	10
LDPE70-Starch30	70	30
LDPE50-Starch50	50	50
LDPE30-Starch70	30	70

2.2. SAMPLE PREPARATION: DUMB BELL SHAPE CUTTING

Upon completion of the synthesis process, the polymer samples were cut into dumb-bell-shaped by a dumb-bell cutter (model SDL-100; Dumb-Bell Co., Ltd.) according to ASTMD 1882L standard. The dumb-bell-shaped samples had smooth surface especially, in the neck section that avoided stress concentration during the mechanical test.

2.3. MECHANICAL CHARACTERISTICS: TENSILE TEST

The tensile test was carried out to investigate the influence of starch content and further the effect of modification processes, namely, crosslinking with TMPTA and EB irradiation on the polymer's mechanical property. The dumb-bell-shaped sample thicknesses were measured by a thickness gauge (Mitutoyo, model EMD-57B-11M) and were keyed in the test system. The tensile test was performed by using a uniaxial testing system (Instron 3365) and a 5 KN load cell (Canton, MA, USA) according to ASTMD1882L standard. The cross-head speed was set at 10 mm/min. For each type of polymer, five samples were tested. Young's modulus was calculated as stress divided by strain to evaluate the mechanical property of the polymer samples. A Student's t-test was performed to compare mean values from all independent sample groups using a Minitab statistics software version 12.2 (Minitab Inc., State College, PA, USA) at a significance level of 0.05.

2.4. DEGRADATION STUDY

The in vitro degradation study was performed on the dumb-bell-shaped LDPE polymer samples containing various percentages of starch (10%, 30%, 50%, and 70%) by burying the polymer samples at the exterior under the soil at a depth of 2 feet for a period of

one month. Each type of polymer had five samples. This study was to primarily investigate the variation of degradation kinetics due to the variation of starch content. The degradation phenomenon was evaluated through mass loss and change in surface morphology. Prior to burial, the polymer samples were characterized by weighing and recording their initial mass using an electronic balance with a resolution of 0.1 mg. After one month of burial, the samples were dug out and cleaned to ensure complete removal of soil/mud. Samples were then placed in an area with sufficient ventilation for natural drying. The dried degraded samples were weighed using the same electronic balance as carried out before starting degradation. Subsequently, the percentage of mass loss of respective sample was measured as follows:

$$\% \text{ Mass loss} = ((Mi - M_f)/M_i) * 100$$

Where M_i, is the initial mass (i.e., mass before degradation) and M_f is the final mass (i.e., mass after degradation).

3. RESULT AND DISCUSSION

3.1. MECHANICAL STUDY

The starch content and modification process (crosslinking TMPTA and EB irradiation) had direct influences on the mechanical characteristics of the starch-incorporated LPDE polymer. The elongation at break of the polymer samples decreased with the increase of starch content, while Young's modulus increased with the increase of starch content as demonstrated in Figures 1 and 2. Figure 1 shows that the drop in elongation at break of the polymer became more prominent as the starch content increased to a higher percentage. This could be due to the reason that, at higher starch contents, filler-filler interaction becomes more pronounced than filler-matrix interaction which reduces the effective cross-sectional area of the polymer sample caused by the presence of starch particles. The applied stress is not transferred accordingly from the polymer matrix to the rigid starch particles, and hence the effective stress experienced by the matrix is essentially higher unlike the elongation, Young's modulus of the synthesized polymer increased with the increase of starch content (Figure 2).

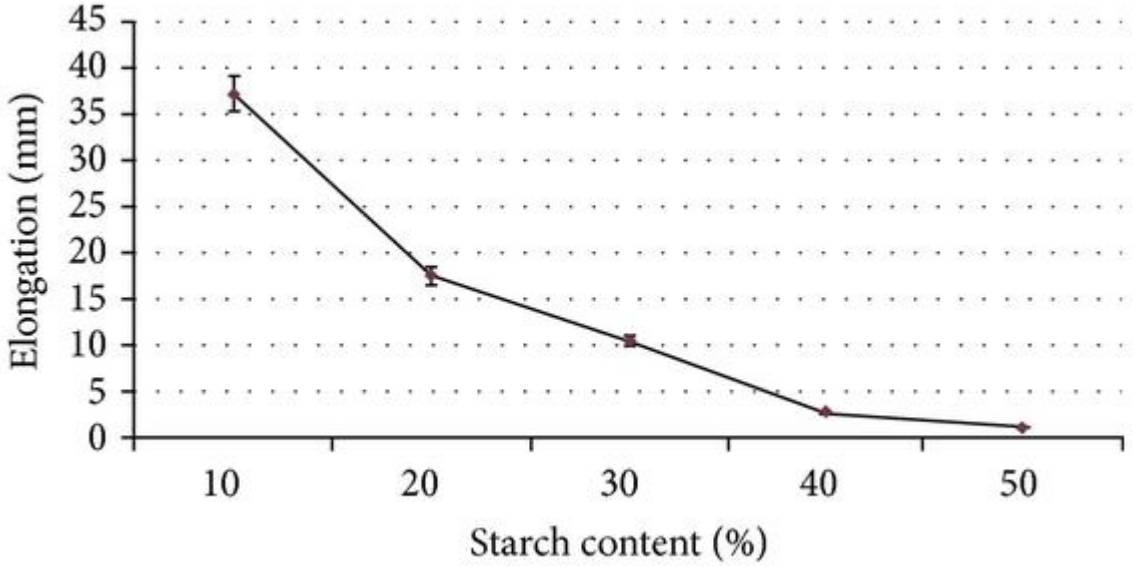
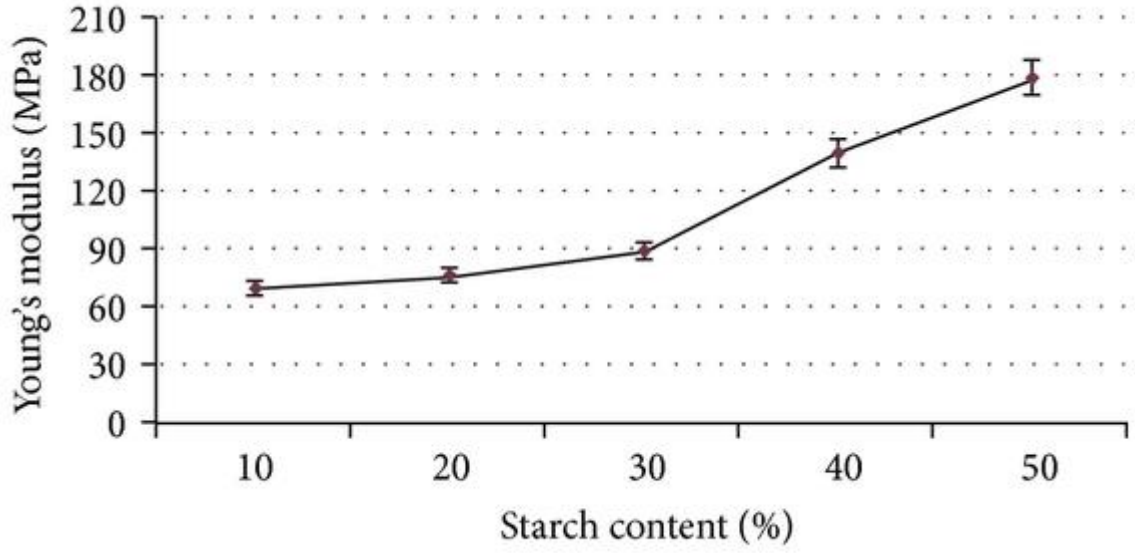


Fig1. Variation of elongation with a starch content of LDPE/starch blends without modification.



3.2.

Fig 2: Variation of Young's modulus with starch content of LDPE/starch blends without modification.

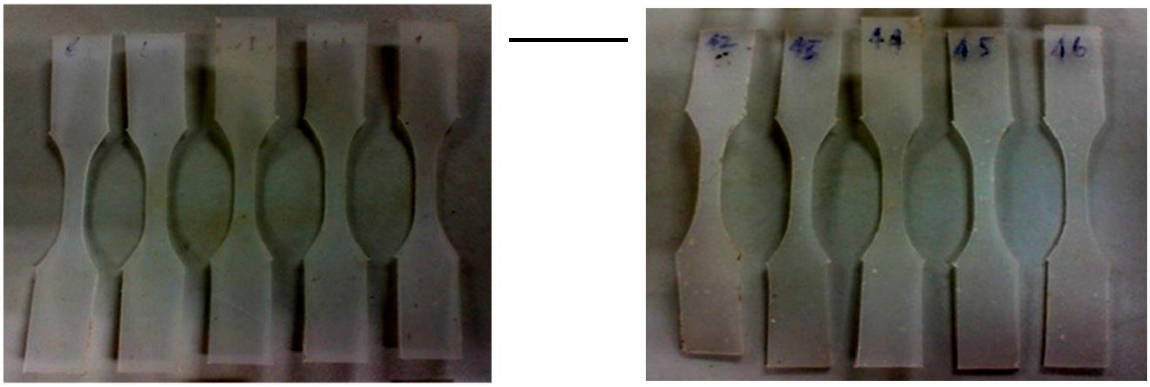
DEGRADATION PROPERTY

The degradation behavior and kinetics of the synthesized LPDE polymer and investigate the variation of degradation kinetics due to the variation of starch content in the polymer. The measured masses before and after degradation of the polymer samples are presented in Table 2 from which ultimately the mass loss (i.e., degradation) is calculated.

Table 2: The mass of LPDE polymer samples (before and after degradation) containing various percentages of starch.

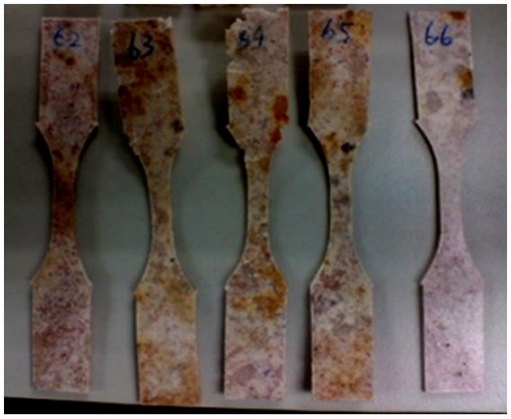
Starch Content (%)	Mass (before degradation) (g)	Mass (after degradation) (g)	Mass loss (%)
0	0.464	0.464	0.00
10	0.452	0.452	0.05
30	0.492	0.496	3.81
50	0.53	0.528	5.37
70	0.632	0.562	11.07

Pure LDPE and low starch containing (e.g. 10%) LDPE showed no apparent mass loss. This result is in agreement with the fact that the pure LDPE is considered to be technically non-degradable, and there should not be any mass loss. Virtually the LDPE polymer sample containing 10% starch should demonstrate some mass loss (i.e., degradation). However, due to time constraints (e.g., too short burial duration), the degradation might not be observed appreciably. Besides, the presence of starch (only 10%) might be too low to render the polymer degrade. The LDPE polymer samples containing 30%, 50%, and 70% starch demonstrated a mass loss of 3.81%, 5.37%, and 11.07%, respectively. These results reveal that higher starch content enhances the degradation kinetics and thus increases mass loss. The degradation characteristic of the starch-mixed LDPE polymer could be modulated by manipulating the starch content in the polymer. Indeed, the polymer should be developed with essentially a controlled degradation characteristic while maintaining the required strength of the polymeric object during its designed lifetime for a particular application. The polymer sample's gross morphology was observed to be changed physically; for example, the surface roughened over the degradation period as seen in Figure 3.



(a) (b)

(c) (d)



(e)

Fig3: Physical appearances of LDPE polymer samples containing various percentages of starch after a one-month long burial that demonstrate different levels of degradation: (a) Pure LDPE, (b) LDPE 90 and Starch 10, (c) LDPE 70 & Starch 30, (d) LDPE 50 & Starch 50, and (e) LDPE 30 & Starch 70.

4. CONCLUSION

The degradation of the polymer was enhanced with the increase of starch content. In conclusion, the starch-incorporated LDPE polymer properties could be modulated by manipulating the starch content and modification processes (e.g., TMPTA crosslinker and EB irradiation dose) for tailored applications. The present study has demonstrated that corn starch would be used in making varieties of biodegradable polyethylene-based plastics for packaging, medicine, agricultural purposes, etc. The cost of corn-starch is less than that of the plastic matrix in the

polyethylene blends, and small starch content led to a significant biodegradation of polyethylene blends. The improved biodegradation of hitherto inert/resistant polyethylene on the incorporation of corn-starch is definitely a factor that needs to be considered by the plastic industries when evaluating polyethylene/corn-starch blends.

5. REFERENCES

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