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# BIODEGRADABLE PLASTIC FROM MIXED STARCH

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**Abstract**

**Every product has a shelf life, but sadly not so with plastics. According to a study by the UN Plastic Collective (UPC), presented by the UN-Environment Program-India, Confederation of Indian Industry (CII) and WWF-India at the CII's Sustainability Summit, worldwide, more than one billion tons of plastic have been produced. -8.3 since then. In 1950 and about 60 percent of that waste ended up in landfills. India, on the other hand, produces 9.46 million tons of plastic waste annually, of which 40% is uncollected. Biological decay of these petrochemical-based substances has been a source of environmental concern and therefore, the ability to drive 'green alternatives' where starch is always at the forefront. The benefits of starch in plastic production include its excellent regeneration of oxygen in an arid environment, abundance, low cost, and environmental decay. Many starchy compounds show bad properties such as strong strength, yield strength, durability, length during breaks, and poor consistency of the mixture. To overcome this, add four vegetable starch like Sago, Maize, Potatoes, and Barley starch to increase strength and use over food, packaging, etc.…,**

## Introduction

In recent years, plastic-based biomaterials have been promising for environmental pollution due to the high impact of plastic waste. Replacing synthetic polymers with decomposing polymers is one of the solutions. The development of decaying packaging materials from renewable natural resources has received increasing attention, while a number of researchers are finding that the use of renewable resources has been revived. It is suggested that, if properly managed, this will minimize the impact on the landfill site. Non-perishable plastics or organic plastics are capable of environmental degradation in some controlled areas. Bioplastic contains polymers from renewable resources, such as Thermo Plastic Starch (TPS) or Poly-Lactic-Acid (PLA) while, TPS, which combines starch and plasticizer, has become another exciting and economically attractive alternative to plastics.

However, water use alone is not desirable because TPS will have poor mechanical properties. Although, a variety of plastics to improve the processing properties and performance of TPS product have been tested. Plasticizers are commonly used to promote the production of plastic starch glycerol, glycol, xylitol, sorbitol, sugar, and amides, such as urea and formamide. Plasticizers play an important role, because plasticizers can form hydrogen bonds with starch, replace strong inter- and intermolecular hydrogen bond starch, and cause starch to exhibit plasticization.

Decaying plastic from mixed starch is an environmentally friendly product. This is because we reduce the amount of chemical compounds by adding starch that does not contain harmful chemicals or reactions when combined with other decaying compounds. Starch is a natural product, so it is harmless. Starch contains amylase, which can easily mix with other chemicals. Mixed starch gelatinization at 70 °C when heated.

The aim of this project is to produce a plastic product that uses 100% raw materials and helps reduce environmental pollution. Specifically, to develop the biodegradable plastic from mixed starch and study the properties such as bio-degradability, mechanical properties and resistance factor in order to produce a good quality of biodegradable plastic products that are eco-friendly.

**Literature Review**

Extensive literature reviews were carried out and some of the important journals which are relevant to our research work are highlighted and reviewed was stated below.

Zur et.al. has developed the biodegradable plastics from sago starch and study based on the FTIR results, this biodegradable plastic is particularly environmentally friendly. The stainless steel based starch in the sago is perishable as FTIR tests show that the main chemical inside the rotting plastic supported by the sago starch has disappeared after 14 days. The yield load is 60.2N, depending on the pressure test machine relative to the length. That means rotting plastic made of sago starch can withstand loads of up to 60.2N.Furthermore, the biodegradable plastic made from sago starch has strong acid resistance but poor alkalis resistance.

Saudi Khalid et.al. successfully developed Polycaprolactone (PCL) and pomegranate rind (PR) based on PCL / starch / PR hybrids using extraction method. PCL is an efficient biodegradable matrix that can be used to produce functional packaging materials, according to scientists, because it can be processed at low temperatures (80 ° C), which is ideal for processing naturally occurring materials. Cornstarch can be used as an effective filler in the development of such materials because it not only allows the active ingredient to flow, but also enhances the mechanical properties of the matrix. Combined PCL / starch / PR films have an economic value, as both starch and PR have reduced material costs.

The morphological features, thermal, visible properties, and decaying materials of the sheets were found to have a significant relationship with both the composition and the processing temperature. Due to the incompatibility of the components, the morphological and thermal properties of the TPS / PCA / PBAT combination revealed different properties. The good integration of TPS and PCA into TPS / PCA combinations, on the other hand, has resulted in better mechanical properties, especially at higher processing temperatures, allowing it to be considered an eco-friendly novel, an economically viable alternative to non-perishable plastic. materials for biomedicine, agriculture, and temporary packaging [3].

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Based on the above lecture review, the main objective of present paper is to produce bio plastic with good strength comparedto bio plastics available in market, Also to study the various properties of the plastic like Tensile Strength, Solubility and Degradability. The product bio – plastic is 100% extracted mixed starch which can be cost efficient and reduces the environmental pollution.

**Properties of Bioplastics and Factors Affecting**

Storage Samples containing high starch content are kept under its Tg to extend their process to achieve thermodynamic equilibrium and chain movement becomes uniform as glass starch reaches thermodynamic equilibrium [5]. Water vapor permeability (WVP) decreases with an increase in glycerol content as non-plastic starch forms brittle films with holes or cracks, including vapor flow, and the formation of holes or cracks is avoided when you add glycerol 20 g to 100 starch, which creates a cohesive structure, leading to a possible decline in WVP values. As the temperature rises, the starch cells vibrate violently, thus breaking the hydrogen bond between molecules and allowing water to enter. As a result, there is plenty of free water available to facilitate the flow of particles to the setup which results in low shear stress values. Start-up power and frequency characteristics vary with different shear rates.

Potential applications require water solubility in order to improve product integrity and water resistance. It has been found that the melting of the film decreases with an increase in the duration of alkaline treatment before gelatinization. In an alkaline solution, the amylose polymer is more versatile than it was in water solution. As the pH increases, continuous growth of negative charge in the polymer molecule is expected leading to an increase in the amylose coil in charge withdrawal.

With a decrease in Young's modulus and Tensile Strength there is an increase in glycerol in the starch film. Direct interaction and closeness between starch chains reduces the incorporation of glycerol-like plasticizer into the starch network. The mechanical properties of starch films are determined by the ratio of amylose to amylopectin. When starch granules are burned in water, inflammation occurs leading to the coagulation and explosion of amylose and amylopectin. Broken amylopectin has a low affinity for binding and provides weak, compact and flexible amylopectin films. While amylose is present in high solution it has a high tendency to interact with hydrogen bonds that form strong and strong gels.

These substances are damaged in the environment in a relatively short time. In addition, studies were performed using biodegradation enzymes that rapidly degrade TPS through α-amylase. Amylose is partially resistant to α-amylase attacks due to starch remaining in the matter. The use of other types of enzymes that can speed up the biodegradation process requires further investigation.

**Materials and Methods**

Starch-based plastics are a complex combination of starch and fertile plastics such as Polylactic acid, Polybutylene Adipate Terephthalate, Polybutylene Succinate, Polycaprolactone, and Polyhydroxyalkanoates. These complex mixtures improve water resistance and processing as well as mechanical properties. Glycerin is a hygroscopic liquid with high viscosity. It has 3 hydroxyl groups that dissolve in water. Glycerin makes bioplastic more flexible.

In the manufacturing of bioplastic, water plays a vital role. It functions as a solvent to dissolve starch in the first instance.

Second, it helps starch molecules remain intact after heating. Vinegar, a 6% volume solution of acetic acid releases acetate ions and hydrogen ions into the solution [6]. This is important, because ions are still sharing polymers with starch polymers and making them more easily soluble in solution. This disruption, caused by water disruption and ionization by acetic acid, makes the resulting cast film look the same.

**Methodology**

The amount of mixed starch of 10g were weighed. Mixed starch contains 4g of corn starch, 3g of potato starch, 2g of sago starch and 1g of barley starch. Mix the starch with water (50 ml) in beaker and heat it using hot plate about 70 degree Celsius. Stir the starch solution and then add glycerine (5 ml) and 5% acetic acid (5 ml) while stirring. Stir the solution until it become colorless and springy [5].

*Alkalinity Test*

*Acidity Test*

Samples (5 g) of the amylose produced were accurately measured and, subsequently, placed in sulfuric acid with a concentration of 10%, 20% and 30%. Samples were dried and weighed periodically for 3 days to determine the percentage of weight loss after each period [7]

**Result and Discussion**

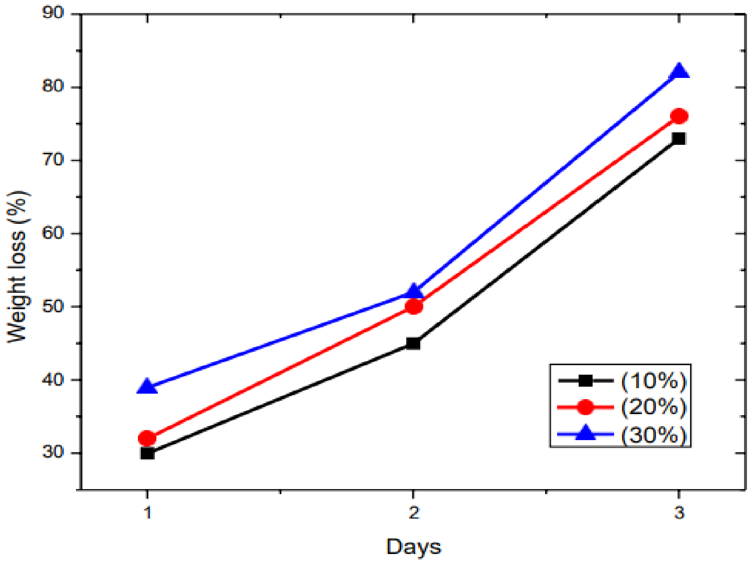



Figure 1. Sago starch

Figure 1. Shows that the weight loss of amylase, produced from or from sago starch, increases as NaOH concentration increases and, again, increases over time. A maximum weight loss of 70% & 69% was observed for amylase from sago starch after 3 days of treatment [8]. It is clear from the results that the resistance of amylase, which is produced from sago starch to alkali, is almost identical; however, the amylase produced in both fossils had a lower alkaline resistance compared to commercial amylase. The presence of hydrolysable ester linkages in the acetate structure, however, resulted in low alkali resistance. Figure 2. Shows that the weight loss of amylase, produced with or from corn starch, increases as NaOH concentration increases and, again, increases over time. 82% and 76% weight loss was observed with amylase from corn starch after 3 days of treatment.

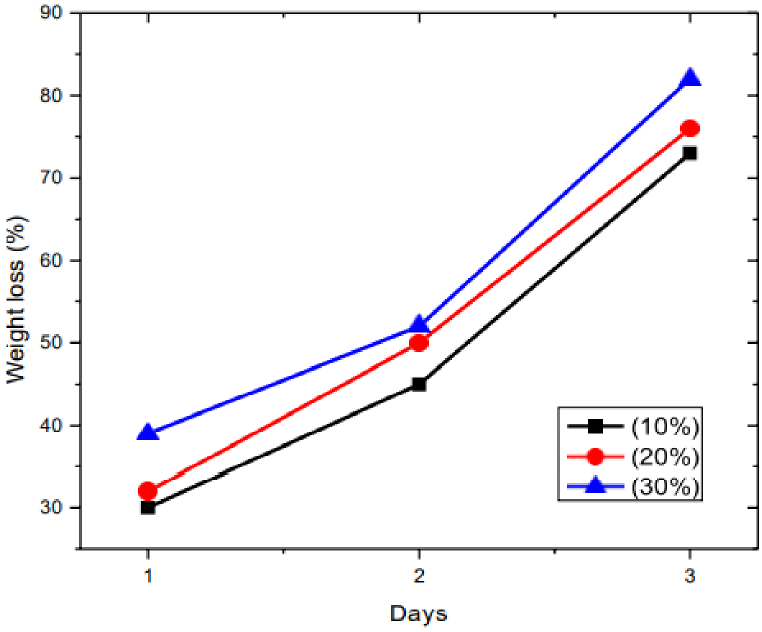



Figure 2. Corn starch

Figure 3. Shows that the weight loss of amylase, was increased over time. A maximum weight loss of 76%n was noticed for amylase from potato starch after 3 days treatment.

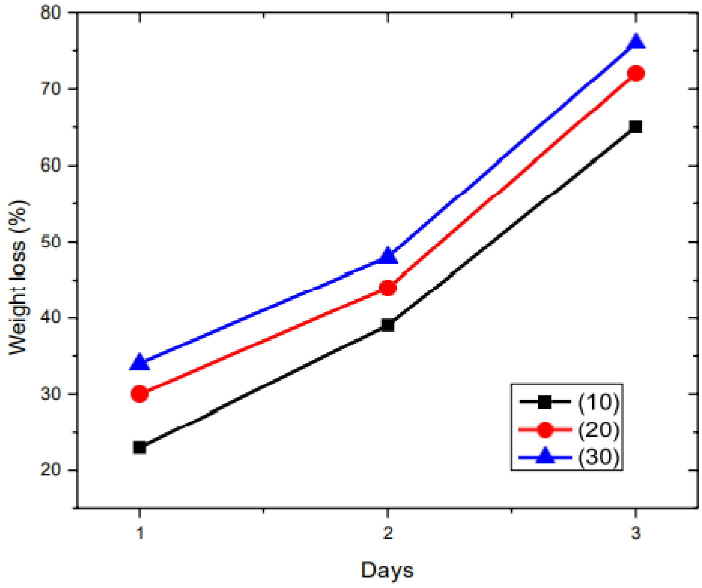



Figure 3. Potato starch

Figure 4. shows that the weight loss of amylase, produced from or from barley starch, increases as NaOH concentration increases and, again, increases over time. 63% and 65% weight loss was observed with amylase from barley starch after 3 days of treatment.

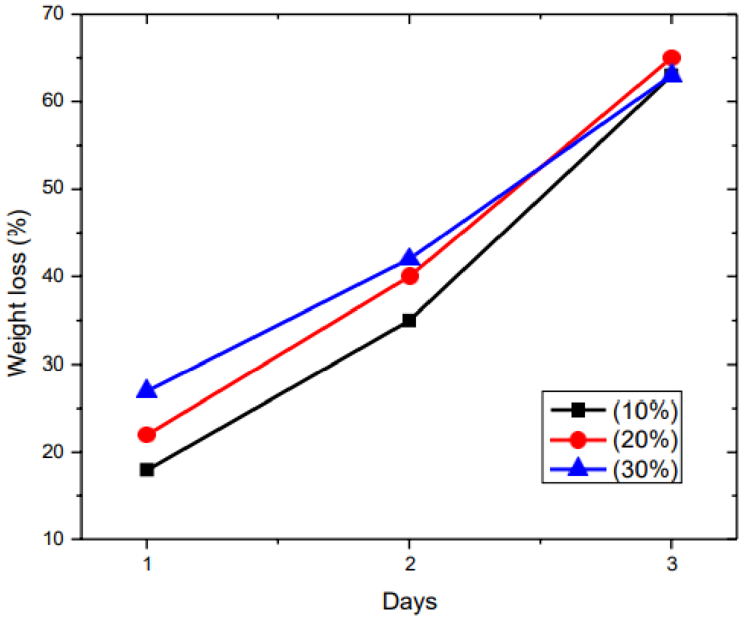
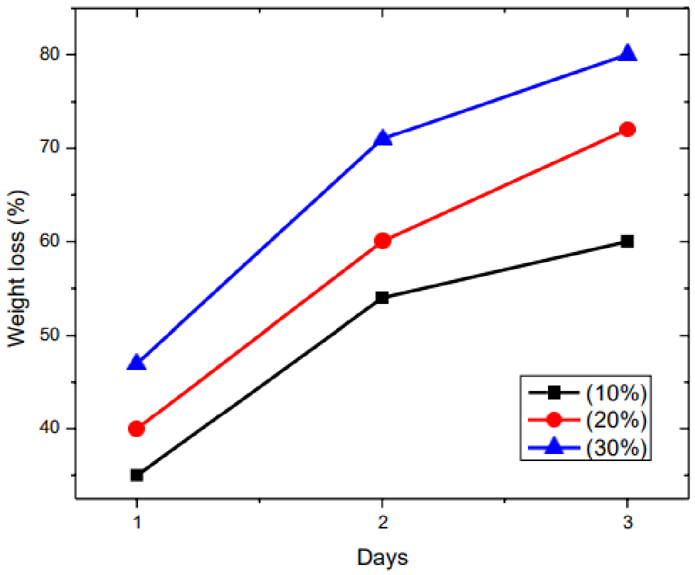


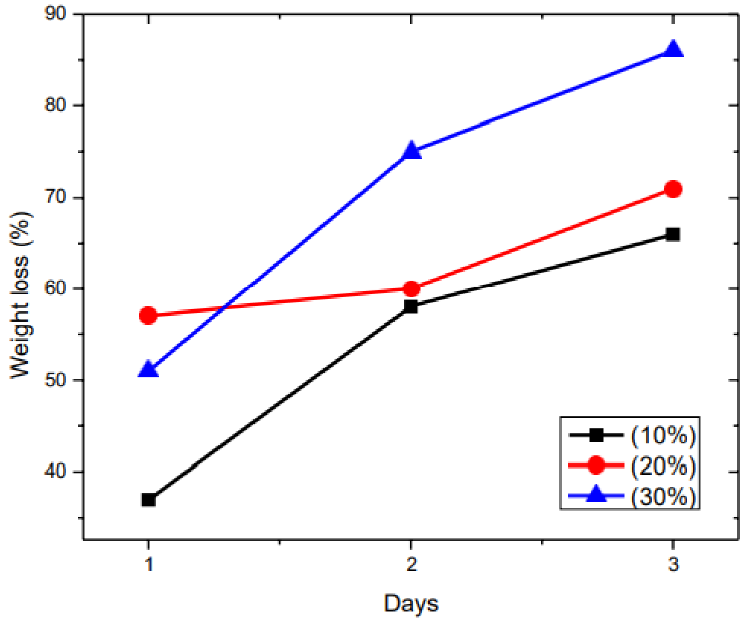

Figure 4. Barley starch

*Acidity Test*

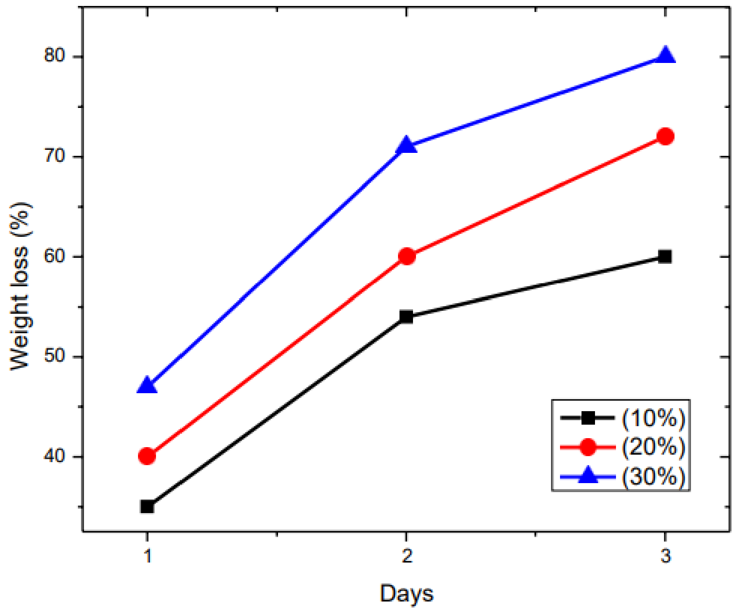
Figure 2. (a), (b), (c) & (d) shows the results from the effects of differential concentration of sulfuric acid on amylase. Weight loss in amylase, produced from sago, maize, potatoes and barley starch, increased by increasing sulfuric acid levels from 10% to 20% and, by reducing amylase weight by 30% sulfuric acid acid. These effects of amylase are explained by the fact that, by increasing the acid concentration from 10% to 30%, the acid content increases and, therefore, the weight loss increases. In general, the production of amylase in both residues had excellent acid resistance.



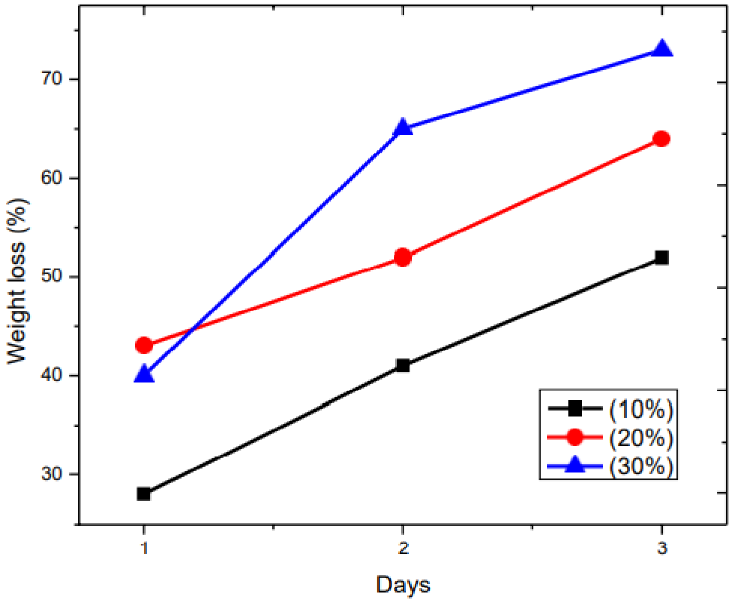

(a) Sago starch




(b) Corn starch




(c) Potato starch




(d) Barley starch

Figure 5. (a), (b) , (c) & (d) Acidity test

*Tensile Strength Test*

Figure 6. Shows the result from the Tensile Strength test load against elongation .dead that the load yield is 11.91 N .This means that BDPSS can load up to 11.91 N before its subsequent switching. The $R^2$ value behind the line is 0.925.

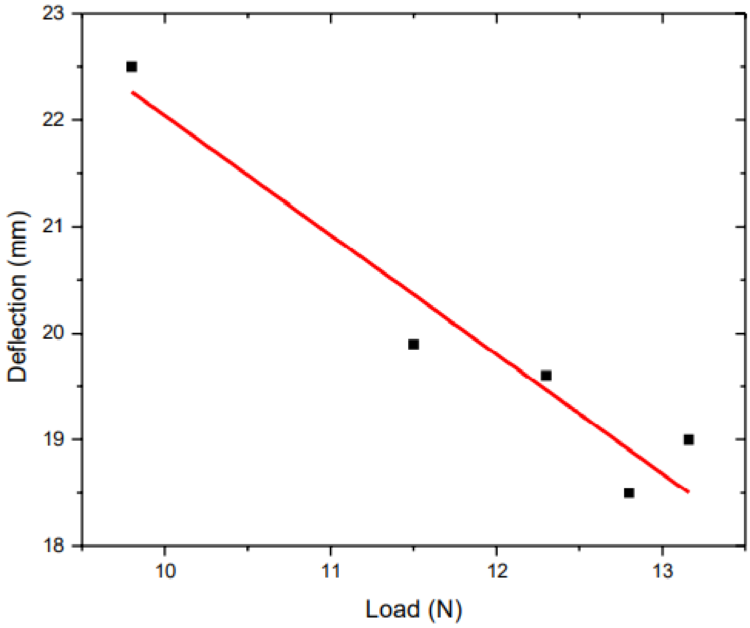



Figure 6. Tensile Strength test of sago plastic

Figure 7. Shows the result from the Tensile Strength test load against elongation. That means BDPCS can applied load until 28.93 N before its change after that. After linearization, the value of $R^2$ is 0.833.

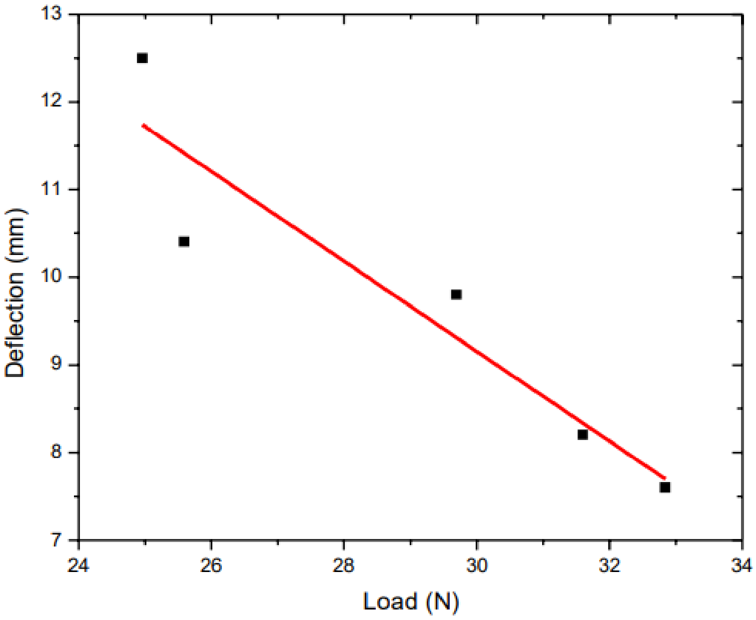



Figure 7. Tensile Strength test of corn plastic

Figure 8 shows the result from the Solid Strength test load against the extension made that the yield load is 28.59 N .This means that BDPPS can load up to 28.59 N before its subsequent conversion. $R^2$ equals 0.925 behind the line.

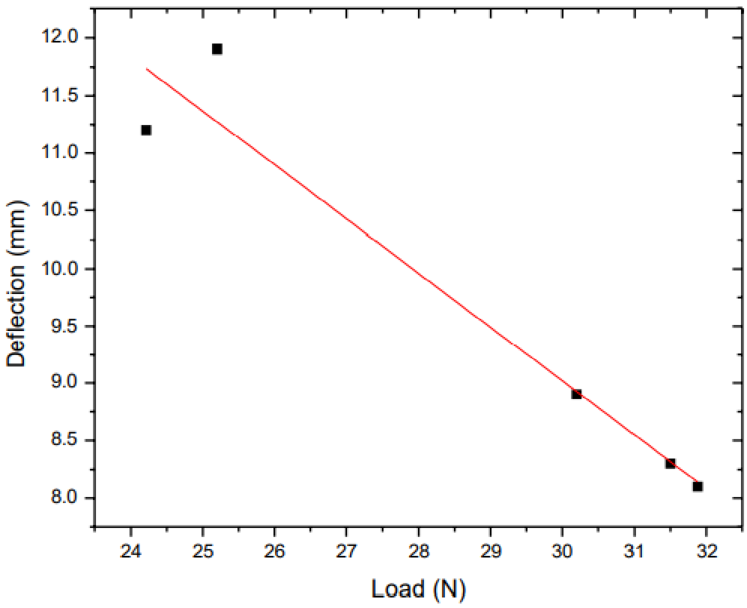



Figure 8. Tensile Strength test of potato plastic

Figure 9 shows the result from the Tensile Strength test load against elongation defining that the yield load is 10.08 N .This means that BDPBS can load up to 10.08 N before the change thereafter. Behind the line, the value of $R^2$ is 0.644.

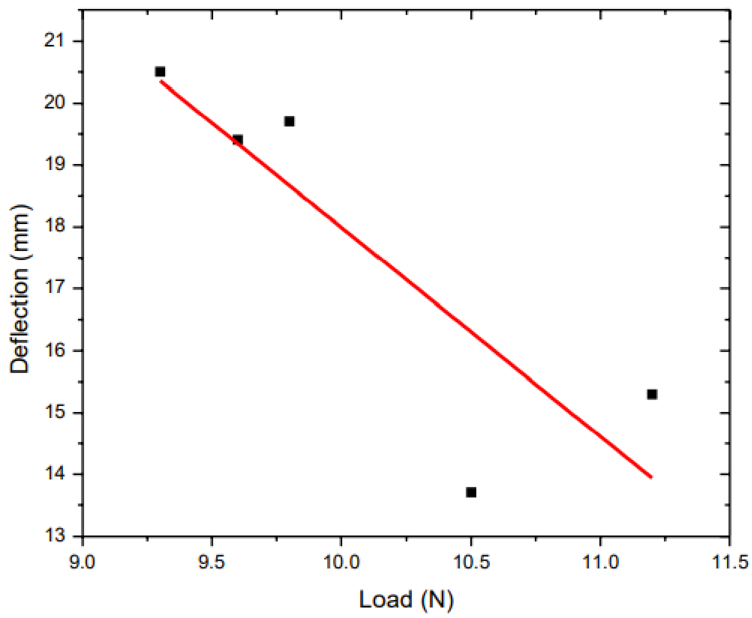



Figure 9. Tensile Strength test of Barley plastic

From the test results of individual starch plastic, it is evident that corn and potato plastic possess good mechanical property, degradability and resistance to acid and alkane groups. The observation gives a clear idea to mix the starches in different ratios. Considerably corn and potato has good strength so these starches have more ratios. The results for mixed starch and mixed starch plastic is given bellow.

*Alkalinity Test for Mixed Starch*

Figure 10 shows that the weight loss of amylase, produced from sago starch, increases as NaOH concentration increases and, again, increases over time. 79% and 74% weight loss was observed with amylase from sago starch after 3 days of treatment. It is clear from the results that the resistance of amylase, which is produced from sago starch to alkali, is almost identical; however, the amylase produced in both fossils had a lower alkaline resistance compared to commercial amylase. The presence of hydrolysable ester linkages in the acetate structure, however, resulted in poor alkali resistance.

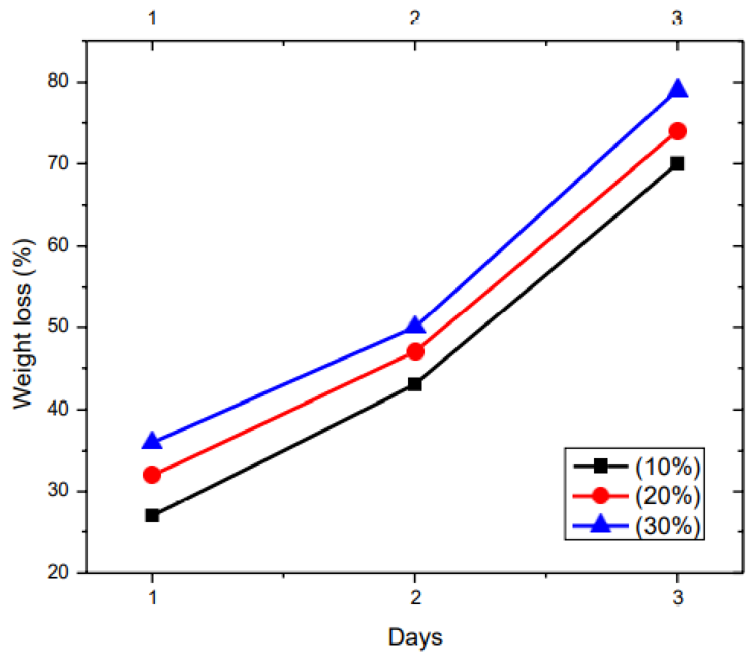



Figure 10. Alkalinity test of mixed plastic

*Acidity Test for Mixed Starch*

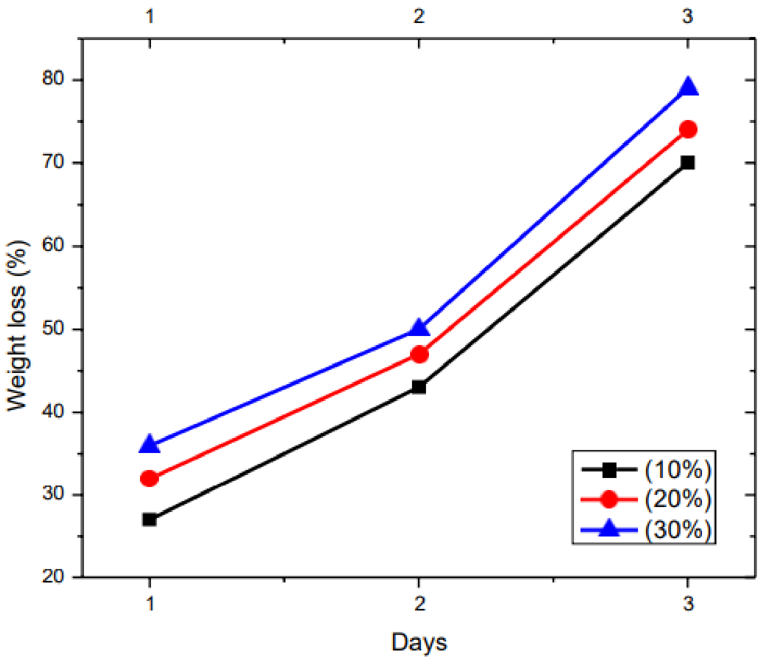



Figure 11. Acidity test of mixed plastic

Figure 11 shows the results from the effects of different concentrations of sulfuric acid on amylase. Weight loss in amylase, produced from sago, maize, potatoes and barley starch, increased by increasing sulfuric acid levels from 10% to 20% and, by reducing amylase weight by 30% sulfuric acid acid. These effects of amylase are explained by the fact that, by increasing the acid concentration from 10% to 30%, the acid content increases and, therefore, the weight loss increases. In general, the production of amylase in both residues had excellent acid resistance.

*Degradation Test*

Figure 12 shows that the result for degradation test. It can be broken down by metabolism by the body. When biodegradable plastic can be digested so that the carbon atom in the polymer chains breaks down and contributes to the formation of other organic molecules. They can be processed and become part of living organisms. This brings them back to nature. They become part of the carbon cycle of global ecology.

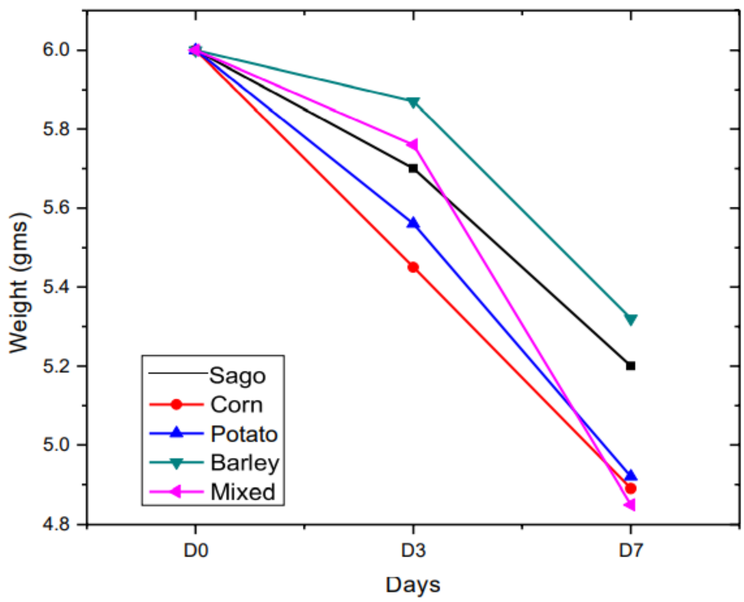



Figure 12. Degradation test

*Tensile Strength Test*

Figure 13 shows the result from the Solid Strength test load against the extension .made that the yield load is 29.11 N. That means BDPSS can load up to 29.11 N before the change thereafter. Behind the line, the value of $R^2$ is 0.929.

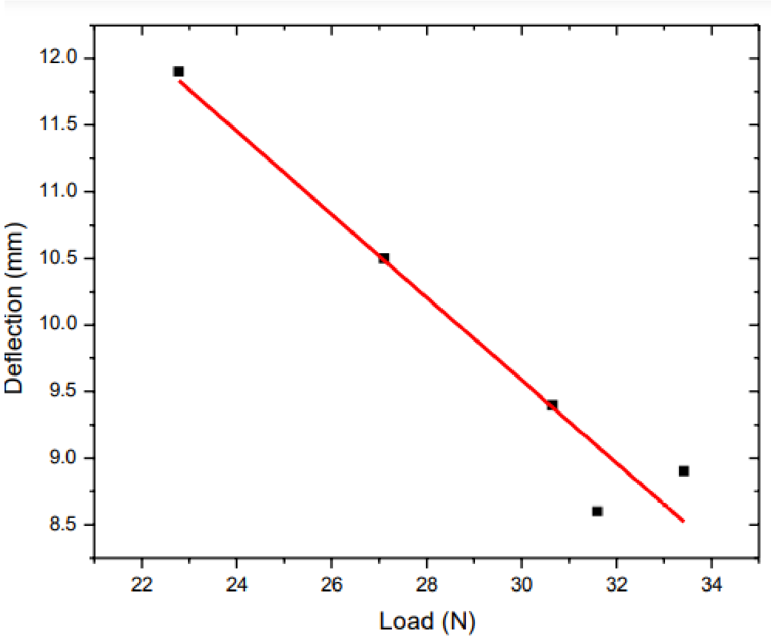


Figure 13. Tensile Strength test of mixed starch plastic

**Conclusion**

Decaying plastic from mixed starch is an environmentally friendly product. This is because we reduce the amount of chemical compounds by adding starch that does not contain harmful chemicals or reactions when combined with other decaying compounds. Starch is a natural product, so it is harmless.

Starch contains amylase, which can easily mix with other chemicals. Gelatinization of starch mixed at 70 ° C when heated. Decaying plastic from mixed starch is successfully made. This perishable plastic is very environmentally friendly. The Tensile Strength test load compared to the extension indicates that the yield load is 29.11 N. This means that the sago-stained plastic sago starch can be loaded up to 29.11N and the sago starch biodegradable plastic is acid resistant. good but alkali resistance is bad.

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