PRODUCTION OF BIOPLASTIC FROM BANANA PEELS

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I. INTRODUCTION

Bioplastics can be defined as plastics made of biomass such as corn, banana peels and sugarcane. Biodegradability of bioplastics has been widely publicized in society and the demand for packaging is rapidly increasing among retailers and the food industry at large scale. Population growth has led to the accumulation of massive volume of nondegradable waste materials across our planet. The accumulation of plastic waste has become a major concern in terms of the environment. Conventional plastics not only take many decades during decomposition, but also produce toxins while degradation. Hence, there is need to produce plastics from materials that can be readily eliminated from our biosphere in an "ecofriendly" fashion. Bioplastics are natural biopolymers synthesized and catabolized by various organisms.

These get accumulated as storage materials in microbial cells under stress conditions. However, the high production cost and the availability of low-cost petrochemical derived plastics led to bioplastics being ignored for a long time. A recent global trend is to use natural, renewable, alternative resources that are beneficial in developing new materials.

II. METHOD AND EXPERIMENTAL PROCEDURE

Similarly sized bananas with no injury or bruises on the skin are purchased from the market in order to ensure the experimental process was fair.

3.1 Preparation of Banana Skins

Step 1: Banana peels are removed using stainless steel knife and converted into small pieces. Then peels are dip in sodium metabisulphite (0.2M) solution for 45 minutes. It is used as antioxidant and preservative. This would increase the biodegradation period of plastic.
Step 2: Banana peels are boiled in distilled water for about 30 minutes.
Step 3: The water is decanted from the beaker and the peels are now left to dry on filter paper for about 30 minutes
Step 4: After the peels are dried, they are placed in a beaker and using a hand blender, the peels are pureed until a uniform paste is formed.

3.2 Production of Plastic

Step 1: 25gm of banana paste is placed in a beaker Step 2: 3ml of (0.5 N) HCl is added to this mixture and stirred using glass rod. Step 3: 2ml Plasticizer (Glycerol) is added and stirred. Step 4: 0.5 N NaOH is added according to pH desired, after a desired residence time. Step 5: The mixture is spread on a ceramic tile and this is put in the oven at 1200 C and is baked. Step 6: The tile is allowed to cool and the film is scraped off the surface.

Heating of Banana peels in the Heating

Drying of peels at atmospheric temperature after heating.

Drying of bioplastic at 120°C in an hot air oven.

Final bioplastic film after drying.

III. REACTION MECHANISM

A Bioplastic of 0.3 mm prepared successfully from above experimental procedure. It is emphasized that presence of HCl and NaOH in proper concentration is consider to be a controlling factor for its strength.
The hydrochloric acid is used in the hydrolysis of amylopectin, which is needed in order to aid the process of film formation due to the H-bonding amongst the chains of glucose in starch, since amylopectin restricts the film formation. The sodium hydroxide in the experiment is simply used to neutralize the pH of the medium. Acid hydrolysis changes the physiochemical properties of starch without changing its granule structure. If the amylopectin content is higher in the starch, the recovery of starch decreases.

Glycerol as a Plasticizer

Plasticizers or dispersants are additives that increase the plasticity or fluidity of a material. The dominant applications are for plastics, especially polyvinyl chloride (PVC) glycerol, sorbitol. The properties of other materials are also improved when blended with plasticizers including concrete, clays, and related products. Plasticizers make it possible to achieve improved compound processing characteristics, while also providing flexibility in the end-use product. Glycerol (also called glycerin) is a simple polyol (sugar alcohol) compound. It is a colorless, odorless, viscous liquid that is sweet-tasting and non-toxic.

Sodium metabisulfite as an Antioxidant

The sodium metabisulfite (Na2S2O5) is used as an antioxidant here. It prevents the microbial growth in the peels. It is used as a disinfectant, antioxidant and preservating agent.it is very soluble in ethanol and water.

IV. TESTING METHODS

The following procedure was adopted to test the tensile strength of the samples. The process has the following steps:

Step 1

Visual inspection of the sample to locate any defects in it. If the sample has no defects it can be used for testing. The common forms of defects are

i) Perforations and tears in the sample.

ii) Very low thickness

Step 2

After the sample is approved for testing, a 16cm by 2cm rectangular film is cut out of the sample for testing which having the thickness about 0.5cm. The film dimensions are kept constant for all samples to ensure uniformity in the testing procedure.

Step 3

The tensile strength of the bioplastic is measured by using “Universal Testing Machine”.

V. EXPERIMENTAL RUNS CONDUCTED

We carried out five experimental runs for the production of bioplastic. Each time we change the concentration of NaOH and HCl. Residence time is also important for the production of bioplastic.

Trial 1 Amount of the paste (ml)	Residence time (min)	Concentration of HCL	Concentration of NaOH	Weight of the dry film (gm)
25	5	0.1 M	0.1 M	3.98
25	10	0.1 M	0.1 M	3.45
25	15	0.1 M	0.1 M	4.77

Status: rejected

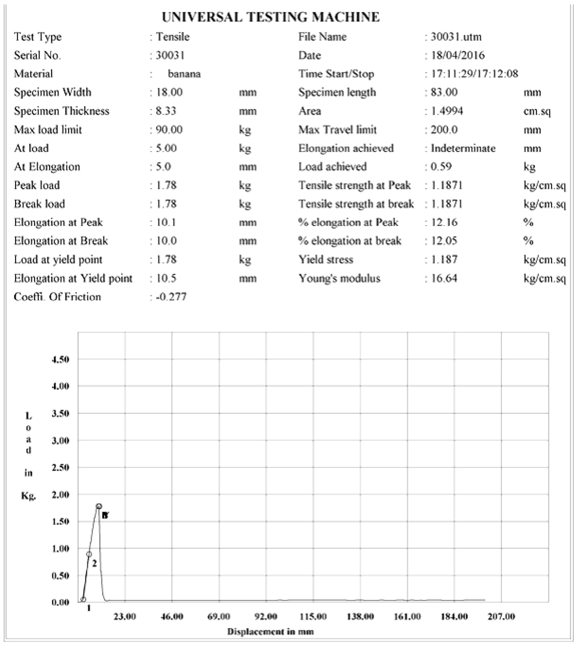
Reason: This trial was rejected due to the presence of perforations in the samples and ineffective heating which made them unsuitable for testing.

Trial 2 Amount of the paste (ml)	Residence time (min)	Concentration of HCL	Concentration of NaOH	Weight of the dry film (gm)
25	5	0.1 M	0.3 M	4.11
25	10	0.1 M	0.3 M	3.89
25	15	0.1 M	0.3 M	4.21
25	20	0.1M	0.3M	4.04

Status: Accepted

All samples are accepted and tested on “Universal Testing Machine

RESULTS AND DISCUSSION



UNIVERSAL TESTING MACHINE

Test Type	: Tensile		File Name	: 30031.utm	
Serial No.	: 30031		Date	: 18/04/2016	
Material	: banana		Time Start/Stop	: 17:11:29/17:12:08	
Specimen Width	: 18.00	mm	Specimen length	: 83.00	mm
Specimen Thickness	: 8.33	mm	Area	: 1.4994	cm.sq
Max load limit	: 90.00	kg	Max Travel limit	: 200.0	mm
At load	: 5.00	kg	Elongation achieved	: Indeterminate	mm
At Elongation	: 5.0	mm	Load achieved	: 0.59	kg
Peak load	: 1.78	kg	Tensile strength at Peak	: 1.1871	kg/cm.sq
Break load	: 1.78	kg	Tensile strength at break	: 1.1871	kg/cm.sq
Elongation at Peak	: 10.1	mm	% elongation at Peak	: 12.16	%
Elongation at Break	: 10.0	mm	% elongation at break	: 12.05	%
Load at yield point	: 1.78	kg	Yield stress	: 1.187	kg/cm.sq
Elongation at Yield point	: 10.5	mm	Young's modulus	: 16.64	kg/cm.sq
Coeffi. Of Friction	: -0.277				

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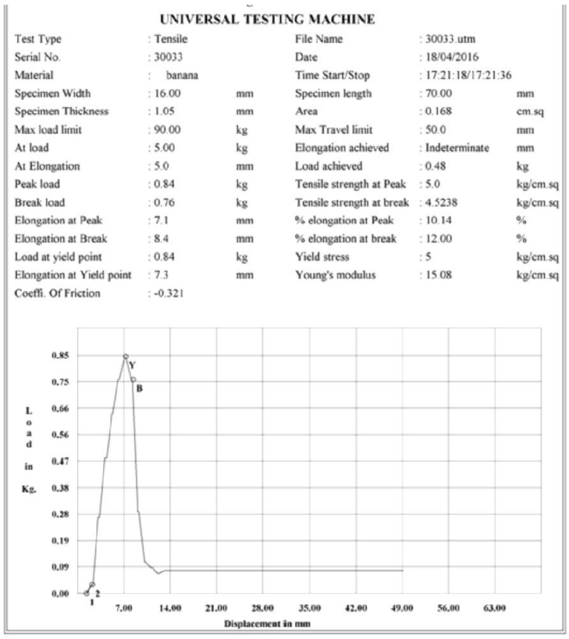

UNIVERSAL TESTING MACHINE

Test Type	: Tensile		File Name	: 30033.utm	
Serial No.	: 30033		Date	: 18/04/2016	
Material	: banana		Time Start/Stop	: 17:21:18/17:21:36	
Specimen Width	: 16.00	mm	Specimen length	: 70.00	mm
Specimen Thickness	: 1.05	mm	Area	: 0.168	cm.sq
Max load limit	: 90.00	kg	Max Travel limit	: 50.0	mm
At load	: 5.00	kg	Elongation achieved	: Indeterminate	mm
At Elongation	: 5.0	mm	Load achieved	: 0.48	kg
Peak load	: 0.84	kg	Tensile strength at Peak	: 5.0	kg/cm.sq
Break load	: 0.76	kg	Tensile strength at break	: 4.5238	kg/cm.sq
Elongation at Peak	: 7.1	mm	% elongation at Peak	: 10.14	%
Elongation at Break	: 8.4	mm	% elongation at break	: 12.00	%
Load at yield point	: 0.84	kg	Yield stress	: 5	kg/cm.sq
Elongation at Yield point	: 7.3	mm	Young's modulus	: 15.08	kg/cm.sq
Coeffi. Of Friction	: -0.321				

Sr. No.	Sample	Residence time (min)	Tensile strength (kg/cm2)	Young’s modulus Kg/cm2	Coefficient of friction
01	Sample 1	5	1.18	16.04	-0.277
02	Sample 2	15	20.95	313.43	-0.303

The tensile strength for sample keeps increasing when the residence times are increased from 5 minutes to 15 minutes and reaches a maximum at 15 minutes and then starts decreasing when the time is increased to 20 minutes. This suggests that the optimum hydrolysis time is 15 minutes for this sample set. During the initial stages of hydrolysis, the amylose content increased, this was attributed to the fact that due the hydrolysis of branched chains of amylopectin, linear chained amylose were formed. However, if the hydrolysis time was increased further, the amylose content decreased albeit slightly. If this hydrolysis time was continued uninterrupted for long durations, the analysis revealed significant drop in the amylopectin and amylose content of starch. This was because once the amylopectin is hydrolyzed to amylase, further hydrolysis leads to formation of glucose monomers which do not aid in polymer formation. The color of the plastic we got is black. It can be change by adding some additives in it. We can use other plasticizer also such as sorbitol for the production of bioplastic.

CONCLUSION

Bioplastic film can sustain the weight near about 2 kg and which have enough tensile strength. The bioplastic prepared from banana peels that can be used as packaging material or as a carrying bag. Glycerol is added as plasticizer that increases its flexibility. To prevent growth of bacteria and fungi sodium metabisulphite is used. The degradation of bioplastic starts after 3 to 4 months from the date of manufacture. The atmospheric condition also effects on degradation period of bioplastic.

Conventional petroleum based plastics creates many environmental problems, so we have to focus more on bioplastic which completely degrade after specific time interval in environment by microbial action. The main advantage of bioplastics over conventional plastic is that they degrade into environment without creating any pollution. Bioplastics is one the best replacement over conventional plastic. By using banana peels as a raw material we can produce good quality bioplastics which has good life.

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