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Production And Characterization Of Eco-Friendly Starch Based Bioplastic Using Potato Peel

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Abstract:

Alarming rate of environmental pollution caused by single-use plastics has necessitated the search for developing sustainable yet, cost-effective alternatives. Bio-based plastics made from renewable resources resolve this issue to a great extent. This study aimed to develop bioplastic films using potato peel as a low-cost starch source. The formulated films’ were characterized using physical, chemical and biodegradable parameters. The developed bioplastic film showed a thickness of 0.107mm, water absorption percentage of 73.61%, swelling percentage of 5.98%, water solubility of 49.16%, and film transparency of 8.74. Whereas in case of chemical resistance the exposure of different solvents for 48h lead to change in properties of film including change in dimension, absorption of liquid, softness or brittleness of material and colour change from dark to light with NaOH, 0.1N HCL, 50% ethanol, 0.1N NaCl reagents, respectively. Biodegradability of films was demonstrated through soil burial method conducted for a month and the weight of the biofilm was observed to decrease almost 10.2%. Bioplastic films developed in this study using low-cost potato peel as a starch source have displayed properties with potential use in day-to-day life and remarkable application in the industrial sector.

Keywords: Environmental pollution, Bio-based plastics, Biodegradable, Potato peel

Introduction

The term "plastic" is derived from the Greek words "plastikos" and "plastos," which means "fit for moulding" and "moulded," respectively. It refers to a material's malleability or plasticity during manufacturing, which allows it to be cast, pressed, or extruded into a wide range of shapes such as films, fibres, plates, tubes, bottles, boxes, and many other things. Plastic is the general term for a wide variety of synthetic or semi-synthetic materials that are used in a vast and expanding range of applications (**Orezzoli *et al.*, 2018**).

The two major processes used to produce plastics are called polymerization and polycondensation, and they both require specific catalysts. In a polymerization reactor, monomers like ethylene and propylene are linked together to form long polymers chains. Each polymer has its own properties, structure and size depending on the various types of basic monomers used. Due to their relatively low cost, ease of manufacture, versatility, and imperviousness to water, plastics are being used all over the world; From drinking cups and disposable silverware to parts for automobiles and motorcycles and they are continuing to rise. As a result they make up about 20% by volume waste per year currently and their lack of degradation is another environmental trepidation. But since plastics are vital to people’s everyday lives, production of biodegradable plastics to make plastics more compatible with the environment is necessary. The first known bio-based plastic, polyhydroxybutyrate (PHB) was discovered in 1926 by a French researcher, Maurice Lemoigne, His work demonstrated the biodegradability of PHB with the bacterium *Bacillus megaterium*. The significance of

Lemoigne's discovery was overlooked for many decades, in large part because, at the time, petroleum was inexpensive and abundant. The petroleum crisis of the mid-1970s brought renewed interest in finding alternatives to petroleum-based products (**Gironi and Piemonte, 2011**). Petroleum-based plastics are not environmentally friendly, since it takes hundreds of years for them to degrade into harmless end-products and petroleum is a finite resource, so sustainable substitutes for plastics are required (**Sin *et al.*, 2013).** Overall the use of synthetic polymers is associated with several drawbacks such as contributing to environmental pollution, high costs of production, and consumption of finite resources. If current trends in plastic production and waste handling continue, it is predicted that around 12,000 Mt of plastic waste will be dumped in landfill or the natural environment by 2050 (**Geyer *et al.*, 2017**). Thus, the utilization of bio-based polymers to generate bioplastics as substitutes for synthetic polymers has received much attention in recent years in packaging applications (**Coppola *et al.*, 2021**).

Bioplastics are defined as plastics made from renewable resources such as potato, sugar, corn etc. (**Karana, 2012; Sarasa *et al.*, 2008**) and produced by a range of microorganisms (**Luengo *et al.*, 2003**). Photodegradable, compostable, bio-based and biodegradable bioplastics are types of bioplastics. Photodegradable bioplastics are light sensitive group due to the additives, and UV can disintegrate their polymeric structure. However, they cannot be disintegrated where there is lack of sunlight (**El Kadi, 2010**). Bio-based bioplastics are derived from renewable resources containing starch, protein, and cellulose (**Alvarez-Chavez *et al.*, 2012**). Bioplastics are not a single kind of polymer but rather a family of materials that can vary considerably from one another. There are three groups in the bio-plastics family, each with its own individual characteristics. Those three groups includes bio-based or partially bio-based non-biodegradable plastics such as bio-based Polyethylene (PE), Propylene (PP), or Polyethylene terephthalate (PET); Bio-based and biodegradable Plastics both such as Polylactic acid (PLA) and Polyhydroxyalkanote (PHA) or Polybutylene succinate (PBS) and fossil based and biodegradable plastics such as Polybutylene adipate terephthalate (PBAT) (**Zhou-Huijuan, 2016**).

Though there are lot of renewable resources available for production of bioplastic, starch is one of the most important sources utilized by many researchers. Starch is made up of amylose (linear) and amylopectin (branched) and has gelatinization characteristics. The linear structure of amylose in starch usually produces bioplastics with stronger and highly fexible mechanical properties, whereas the branched structure of amylopectin produces bioplastics which show lower resistance to tensile strength and elongation property (**Fakhoury *et al.*, 2012**). Starch in its native state exhibits very limited application because of poor solubility, thermal decomposition, high retrogradation, syneresis and low shear stress resistance (**BeMiller and Whistler *et al.*, 2009**). Using starch as a renewable source has several advantages such as low cost, inexhaustible and renewable. Starch is one of the major sources in the development of biodegradable bioplastic. Many previous studies have been conducted by using starch as a natural biopolymer (**Astuiti and Erprihana, 2014**). Starch-based biodegradable plastics are water-sensitive, have high water vapor permeability and generally provide films with mechanical properties unsuitable for many applications, which have hindered the expansion of their use and justifies the need to make modifications to improve their properties (**Mbey *et al.*, 2012**). Potato peel is one of the essential bio-waste materials for bioplastic manufacturing as around 70-140 thousand tons of potato peels are produced each year throughout the world **(Wu, 2016).** Potato peels-based bio-plastics have high concentration of starch containing polymer chains such as amylose and amylopectin **(Khazir and Shetty, 2014).** In this study, the overall purpose was to investigate the utilization of potato peels in order for the bioplastic production. In addition, some properties of the produced bioplastics such as water absorption capacity, film transparency, swelling percentage, water solubility, chemical resistance and biodegradability were analysed.

2. Material and Method

2.1. Bioplastic production

Potatoes were washed up with tap water and peeled properly. 25gm of potato peel paste was placed in a beaker. 3ml of 1N HCl was added to this mixture and gradually stirred using glass rod. Thereafter 2ml of plasticizer (Glycerol) was added and again stirred. 1 N NaOH was added according to pH 7.5, after a desired residence time. The mixture was spread on a ceramic tile and this was put in the oven at 120°C and baked within 4-5 h. The tile is allowed to cool and the film is scraped off the surface **(Figure 1; Modified Gaonkar *et al.*, 2018).**

2.2. Characterization of bioplastic film

Characterization of produced bioplastics will be done by using following techniques including physical and chemical properties:

2.2.1. Physical properties

i) Thickness

A handheld screw gauge (ssu 0–25 mm Micrometer Screw Gauge, India) was used for measuring the thickness of the bioplastic films. The bioplastic films produced were cut into 2 cm × 2 cm dimension for testing. At random positions, the thickness of film samples measured and values were noted. The mean values of thickness were used.

ii) Swelling percentage

The swelling percentage was determined by standard ASTM D570. The bioplastic films were cut into 2 cm x 2 cm dimension and dried at 60°C in hot air oven. Initial thickness of the samples was measured. The films were kept immersed in water for 24 h. Thickness of the samples after immersion was measured using following formula:

$$\text{Swelling \%} = Th_1 - Th_0 / Th_0 \times 100$$

Here Th_0 and Th_1 are thickness of the sample before and after immersion in water, respectively.

iii) Water absorption percentage

The bioplastic films were cut and dried in hot air oven. Initial mass of the films was noted. The films were immersed in the water for 24 h and mass after immersion were measured by using following formula:

$$\text{Water absorption \%} = M_1 - M_0 / M_0 \times 100$$

Here M_0 and M_1 are mass of the sample before and after immersion of the sample in water, respectively.

iv) Water solubility

Water solubility of the film samples was determined using **Saberi *et al.*, 2017** method. All the bioplastic film samples were cut into 2 cm × 2 cm pieces, dried at 60°C for 2 h and weighed. The dried pieces of films were immersed in 20 ml of distilled water in petri-plate and kept on a rocker for 24 h at room temperature. After 24 h, the films were observed for solubility. The residues were dried at 110°C for an hour and then weighed to calculate the percentage of the solubility of the films using below mentioned formula:

$$\text{Solubility\%} = W_0 - W_1 / W_0 \times 100$$

Here, W_0 is initial dry weight and W_1 is final dry weight of bioplastic film.

v) Film transparency

Film transparency of the bioplastic film was determined according to the modify **Mulyono *et al.*, 2015** method. The bioplastic films were cut into 1 cm × 3 cm in order to match the width and height of cuvette. The films were attached to the side of the cuvette. Absorbance was recorded at 600 nm. Transmittance was calculated using following equation:

$$\%T = \text{antilog}\,(2 - \text{absorbance})$$

The transparency was determined using the mentioned formula:

$$\text{Transparency} = \text{Log}\%\,T/b$$

Here, T is transmittance at 600 nm in percentage and b is the thickness of bioplastic in mm.

2.2.2. Chemical resistance

The bioplastic film was immersed in different solvents (0.1 N HCl, NaOH, 0.1 N NaCl solution and 50% ethanol) for 48 h, and measured their resistance against solvents to observe the change in appearance (**Jack *et al.*, 2017**).

2.2.3. Soil Burial Degradation

The bioplastic film was cut into small strips. The film was buried under the soil for assessing natural landfill degradation at different intervals of time. Bio-degradation of bioplastic film was observed up to 30 days with 5 days of intervals (**Krishnamurthy and Amritkumar, 2019).**

2.3. Statistical Analysis

All the experiments were done in triplicate forms and the results were represented as mean ± standard error. Duncan's multiple range tests was used to calculate the all data. P values of <0.05 and Student's t-test p values of <0.001 were known to be statistically important (Montgomery, 1976).

3. Result and discussion

3.1. Physical properties

i) Thickness

Thickness is included in physical properties that can determine the quality of the bio-plastics. The increase in starch concentration is associated with higher concentrations of amylose and amylopectin which results in higher solids content in the film-forming solution and, consequently, the formation of a more viscous paste giving rise to thicker films (**Rusli *et al.*, 2017**). In the present study the average thickness of potato peel-based biofilm was 0.107mm as shown in Table 2. In a study of **Susilawat *et al.*, 2019** determined the thickness of chitosan (K) and gelatin (G) added biofilm manufactured at four different treatments A, B, C and D. The materials used include fresh tilapia bones, modified tapioca flour, chitosan, gelatin, 6% hydrochloric acid (HCl), 1% acetic acid (CH_3COOH), glycerol, aquades and the thickness of A (2% K, 5% G) was 0.072 mm, B (3% K, 10% G) was 0.148mm, C (4% K, 15% G) being 0.227mm and D (5% K, 20% G) was 0.332mm. Likewise, **Santana *et al.*, 2018** reported that thickness of starch-based bioplastics from jackfruit seed made with different concentrations of starch and glycerol ranged from 0.099 to 0.1599 mm**.** In a study by **Anchundia *et al.*, 2016** involving edible films, a thickness of 0.11 mm was reported when using 0.5% banana peel and a 0.17 mm thickness with 1.5% banana peel.

ii) Swelling percentage

In present study the average swelling percentage of starch based bioplastic from potato peel was 5.98% as shown in Table 1. **Krishnamurthy and Amritkumar**, **2019** reported three composite bioplastic films which were developed using starch mix with lemon extract and water but with different cross-linkers: (1) PV (polylactic acid and crude palm oil), (2) AV (glycerol and crude palm oil), (3) PAV (polylactic acid, glycerol and crude palm oil) which had swelling percentage of 39.9%, 2.94% and 29.6 % respectively. PV film took up thrice the amount of water content than AV film, and PAV had swollen twice the amount of that of AV. The crystalline nature of starch is destroyed in the presence of heat and excess water during melting process that makes the amylose and the branched chains of amylopectin to break and form hydrogen bonding. Additionally, there may be some exposed hydroxyl groups of amylose and amylopectin not involved in cross-linking with plasticizers, which react with water when exposed leading to swelling of the film. **Dhivya *et al.*, 2021** studied the possibilities of producing the bioplastics material from the leaf extract of *Ricinus communis* and the swelling ratio of the bioplastic was as 14.28%. **Fathanah *et al.*, 2015** made a bioplastic by mixing starch and chitosan with glycerol as plasticizer by using cassava peel as raw material. Physical property of resulted bioplastic was obtained from the best swelling test at addition of 40% chitosan i.e. 0.38%. **Vijayalaksmi *et al.*, 2022** reported significant water swelling test results of banana peel starch-based bioplastic that proved as biodegradable plastic.

iii) Water absorption percentage

The absorption of water is directly proportional to the quantity of starch (**Rahmatiah and Liew, 2016; Azahari *et al.*, 2011; Aranda-Garcia *et al.*, 2015**). In the current study the average water absorption percentage of starch-based bioplastic from potato peel was 73.61% as shown in Table 2. **Krishnamurthy and Amritkumar**, **2019** worked on three composite bioplastic films which were developed using starch mix with lemon extract and water but with different cross-linkers: (1) PV (polylactic acid and crude palm oil), (2) AV (glycerol and crude palm oil), (3) PAV (polylactic acid, glycerol and crude palm oil) which had water absorption percentage of 284.5%, 33.3% and 178.6% respectively. **Azmin and Nor, 2020** conducted a study to develop biodegradable plastic films by using cocoa pod husk and sugarcane bagasse. Cellulose and fibre were extracted from cocoa pod husk and sugarcane bagasse, respectively. The developed bio-plastic films were divided into several concentration ratios of cellulose and fibre. The highest water absorption is given by 50:50 (ratio of cellulose to fibre) bioplastic with 46.76%, while the lowest water absorption is 17.62% provided by 75:25 (ratio of cellulose to fibre) bioplastic. The trend of water absorption decreased from 25.63% (100% cellulose-based plastic) to 17.62% (75:25 bioplastic) but, increased for 50:50 (ratio of cellulose to fibre) bioplastic with 46.76%. Similarly, water absorption experiments of **Arikan and Bilgen, 2019** reported that potato peel bioplastic absorbed water by 48.46% within two hours and 83.57% within 24 hours. It was also observed that commercial bioplastic absorbed water by 2.04% within two hours and 7.48% within 24 hours. It was observed that the potato peel bio-plastic had maximum potential of water absorption as compared to the commercial bio-plastic. **In 2023, Mund and Shrivastava** reported higher (79%) water absorption with potato-peel bioplastic has 97.2% glycerol as compared to the 2.4% glycerol from which 37% absorption was observed.

iv) Water solubility

The retention and sustainability nature of attained molecules are studied through the solubility assay (**Krishnamurthy and Amritkumar**, **2019)**. The solubility of the films is an indicator of the presence of hydrophilic compounds in the film. In the current study the average water solubility of starch-based bioplastic from potato peel was 49.16% as shown in Table 3. **Krishnamurthy and Amritkumar**, **2019** stated three composite bioplastic films which were developed using starch mix with lemon extract and water but with different cross-linkers: (1) PV (polylactic acid and crude palm oil), (2) AV (glycerol and crude palm oil), (3) PAV (polylactic acid, glycerol and crude palm oil) which had solubility percentage of 70%, 12% and 45.45% respectively. Bioplastics generated in the study of **Mroczkowska *et al.*, 2021** were fully water soluble but could substantially delay the onset of full aqueous disassembly. Bioplastics made with piscine gelatine lost significantly less weight, at 38 ± 0.003% over 24 h in water, compared to bioplastics made with porcine (41 ± 0.009%) or bovine gelatine (48 ± 2.8%). Likewise, **Oluwasina *et al.*, 2021** reported the effect of varying concentrations of dialdehyde starch and silica solutions on the physical properties of the bioplastic films, in which the film solubility was recorded to be 4.23–7.90%.

v) Film transparency

Transparency is the ability of a material that can indicate the level of clarity of a material marked by the ability of the material to transmit the light (**Wattimena *et al.*, 2016).** In the current study the average film transparency of starch-based bioplastic from potato peel was analysed to be 8.74 as estimated and shown in Table 4. **Mulyono *et al.*, 2015** achieved maximum transparency value of 3.13 for tapioca film whereas **Krishnamurthy and Amritkumar**, **2019** reported three composite bioplastic films which were developed using starch mix with lemon extract and water but with different cross-linkers: (1) PV (polylactic acid and crude palm oil), (2) AV (glycerol and crude palm oil), (3) PAV (polylactic acid, glycerol and crude palm oil) which had film transparency of 5.57, 4.56 and 5.86 respectively.

(a) (b) (c)

Figure 1: Bioplastic preparation: (a) potato peel paste (b) Mixture spread on tile before placing it in oven (c) bioplastic film formed

Table 1: Swelling % of bioplastic film

Potato bioplastic film (PBF)	Thickness of the film before immersion in water (Th_0)	Thickness of the film after immersion in water (Th_1)	$Th_0 - Th_1$	Swelling %
PBF1	0.38	0.40	0.02±0.005	5.26
PBF2	0.48	0.52	0.04±0.005	8.33
PBF3	0.46	0.48	0.02±0.005	4.35
Average				5.98

Above data are represented significant values. Duncan’s multiple range test was done to calculate the above data considering P=0.01.

Table 2: Water absorption % of bioplastic film

Potato bioplastic film (PBF)	Mass of the film before immersion in water (M_0)	Mass of the film after immersion in water (M_1)	$M_0 - M_1$	Water absorption %
PBF1	0.27	0.48	0.21±0.005	77.77
PBF2	0.30	0.51	0.21±0.01	70
PBF3	0.26	0.45	0.19±0.01	73.07
Average				73.61

Above data is represented as mean values. Duncan’s multiple range test was done to calculate the above data considering $P<0.05$.

Table 3: Water solubility % of bioplastic film

Potato bioplastic film (PBF)	Initial dry weight (W_0)	Final dry weight (W_1)	W_0- W_1	**Water solubility %**
PBF1	0.25	0.12	0.13±0.0061	52
PBF2	0.30	0.17	0.13±0.0067	43.33
PBF3	0.23	0.11	0.12±0.0055	52.17
Average				49.16

Above data is represented as mean values. Duncan's multiple range test was done to calculate the above data considering $P<0.05$.

Table 4: Transparency analysis of bioplastic film

Potato bioplastic film (PBF)	**Absorbance (600 nm)**	**Transmission %**	**Thickness (in mm)**	**Transparency**
PBF1	1.028	9.37	0.102	9.52
PBF2	1.109	7.78	0.105	8.48
PBF3	1.045	9.02	0.116	8.23
Average	**1.060±0.042**	**8.72±0.83**	**0.107±0.0073**	**8.74±0.68**

Above data is represented as mean values. Duncan's multiple range test was done to calculate the above data considering $P<0.05$.

3.2. Chemical resistance

The bioplastic film was exposed to different chemical solvents, and their effect on the films was observed as given in Table 5. All the formulated films were affected by strong alkali as compared to other solvents. **Samraj *et al.*, 2022** investigated that the properties of bioplastic obtained from wheat gluten and fish scales and their findings on a comparison between the produced bioplastic and the other known types of plastic, a sample of polystyrene (A, B and C) suggested that the weight loss of the produced bioplastic increased by increasing the concentration of sulfuric acid from 10% to 20%, and then, the weight loss of the bioplastic became reduced at a 30% sulfuric acid concentration. These results can be explained by the fact that, by increasing the acid concentration from 10% to 20%, the acid content increased and, hence, the weight loss increased. Similarly, as the concentration of NaOH increased, the weight loss increased. The total weight loss of samples A, B, and C was 54%, 57%, and 58%, respectively, after 10 days for 30% NaOH. Compared to polystyrene, which lost 48% of its weight when exposed to alkalis, the bioplastic that was made did not react well to alkalis. As reported by **Krishnamurthy and Amritkumar**, **2019** used three composite bioplastic films which were developed using starch mix with lemon extract and water but with different cross-linkers: (1) PV (polylactic acid and crude palm oil), (2) AV (glycerol and crude palm oil), (3) PAV (polylactic acid, glycerol and crude palm oil). All the formulated films were affected by strong acid (0.1M HCl). They absorbed the solvent and got softened in alkali which could be due to the presence of acid in the film which reacted and neutralized. PV and PAV films became soft in all the solvents, while AV film showed brittleness when exposed to 50% ethanol.

Table 5: Chemical resistance of bioplastic film

Solvent	Properties
0.1N NaOH	a, b, c, e
0.1N HCl	a, b, c, d, f
50% Ethanol	a, b, c, d, f
0.1 N NaCl	a, b, c, d, f

***Interpretation parameters: a - change in dimension; b- not dissolved in the liquid; c -absorbed the liquid, d- softened; e - brittle: f- colour change from dark to light**

(a) (b) (c) (d)

Figure 2: Chemical resistance of potato bioplastic in (a) 0.1 N HCl solution (b) 0.1 N NaCl solution (c) 0.1 NaOH solution d) 50% ethanol

3.3. Soil Burial Degradation

All the soil buried bioplastic samples were taken from the soil at different intervals. The bio-degradation rates were closely observed up to 30 days. Initially the biofilm weighed 0.68gm and post 5 days of burial there was 1.4% decrease in weight which remains unchanged even at 10th day. Likewise, on 15th and 20th day 4.4% reduction of weight was observed. On 25th day the weight showed remarkable decline of 7.3 % and lastly on 30th day an overall weight reduction was seen 10.2% from initial weight as shown in Table 6 and Figure 3,4. The observation clearly signifies the biodegradable property of the potato biofilm. In a study conducted by **Wahyuningtiyas and Suryanto, 2017** developed bioplastic from Cassava flour with different proportions of glycerol from 1 to 3% and tested its biodegradation by soil burial. The mass of bioplastic got reduced within a week, and complete degradation was attained in 9–12 day interval because of moisture uptake. Compared to their study, our bioplastic films had ability to withstand biodegradation for a longer period. Similarly, **Krishnamurthy and Amritkumar**, **2019** reported degradation of three composite bioplastic films, in which included PV (polylactic acid and crude palm oil), AV (glycerol and crude palm oil) and PAV (polylactic acid, glycerol and crude palm oil). On day 15, the size and colour the bioplastic films changed and started to degrade slightly. On day 30, the PV film started to disintegrate more when compared to other films. Fungal growth was observed over AV film. PAV film got mixed well with soil and started degrading. On day 45, PV film disintegrated into pieces and half of the sample got degraded, 20% of AV film had degraded, and 35% of PAV film had degraded. On day 60, PV film got completely degraded, 50% of AV film and 80% of PAV film got degraded. No change was observed in synthetic polythene throughout. It was observed that starch-based bioplastics have the ability to degrade quickly when compared to the synthetic plastics. In the study of **Adhikari *et al.*, 2016** the degradation ratios of PBS (Poly-butylene succinate)-starch, PBS (Poly-butylene succinate), and

PLA (poly lactic acid) after 28 days were 24.4%, 16.8%, and 13.8%, respectively, these bioplastics were degraded faster than the commercial bioplastics.

Table 6: Soil burial degradation of biofilm

S. No	Days	Weight of potato biofilm (PBF)			Average weight	Percent reduction
		PBF$_1$	PBF$_2$	PBF$_3$		
1.	0	0.65	0.68	0.71	0.68±0.03	-
2.	5th	0.65	0.67	0.70	0.67±0.025	1.4%
3.	10th	0.64	0.67	0.70	0.67±0.03	1.4%
4.	15th	0.63	0.65	0.68	0.65±0.025	4.4%
5.	20th	0.63	0.66	0.66	0.65±0.017	4.4%
6.	25th	0.62	0.64	0.65	0.63±0.015	7.3%
7.	30th	0.60	0.62	0.63	0.61±0.015	10.2%

Above data is represented as mean values. Duncan's multiple range test was done to calculate the above data considering $P<0.05$.

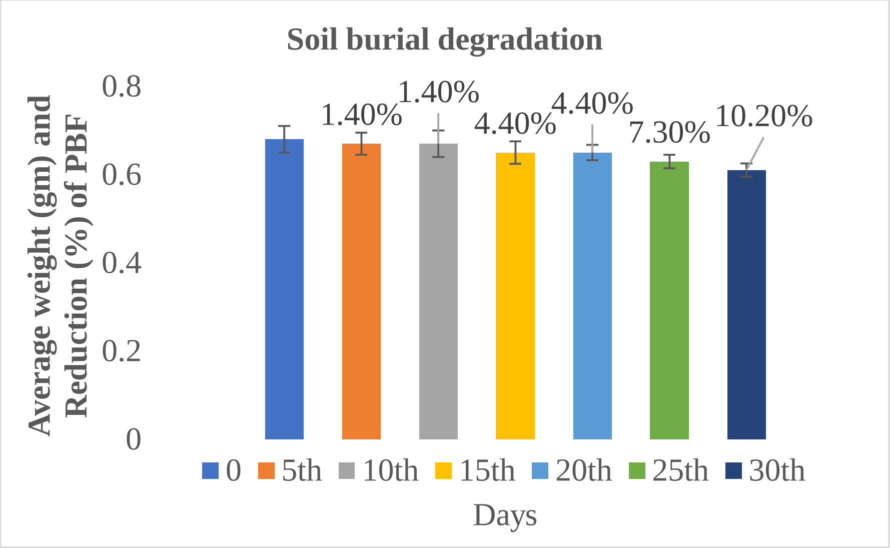

Figure 3: Soil burial degradation of biofilm

(a) (b)

Figure 4: Degradation of biofilm: (a) 0 day (b) 30th day

Conclusion

This study was conducted with an aim to synthesize eco-friendly and cost-effective bioplastic from potato peel. The film displayed different properties with respect to physiochemical parameters. The produced starch-based bio-film had thickness of 0.107mm and swelling percentage of 5.98%, a water absorption percentage of 73.61%, water solubility percentage of 49.16% and a film transparency of 8.74. The biofilm showed variation in properties including change in dimension, absorption of liquid, softness or brittleness of material and colour change from dark to light when treated with NaOH, 0.1N HCL, 50% ethanol, and 0.1N NaCl. The bio-mass of bioplastic films was reduced 10.2% representing the biofilm a potential source of biodegradable plastic. The results concluded that potato peel can be used to make starch-based bioplastic which can serve as a safe and alternative source for synthetic single-use polythene plastics and demonstrated characteristics with prospective use in everyday life as well as notable application in the industrial sector.

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