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# Synthesis of Bioplastic from Tridax procumbens

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**Abstract**

Plastics are a synthetic non-degradable polymer material used for all applications almost everywhere to meet the growing demands. The conventional plastics take long periods to degrade, upto 100 years and it leads to environmental issues. Bioplastics are degradable polymer material which will degrade at a shorter time period and hence is a most promising alternative for conventional plastics. The current study describes the synthesis of bioplastic from *Tridax procumbens* leaves a source of natural polymer along with addition of PVA (Polyvinyl alcohol), Glycerol and citric acid plasticizers. The prepared bioplastic S-1 (25ml of *T.procumbens extract*, 2g of PVA, 1ml of glycerol and 1g of citric acid), S-2 (25ml of *T.procumbens* extract treated with HCl, 2g of PVA, 1ml of glycerol and 1g of citric acid) both shows a good characteristic with smooth surface, transparent and flexible nature. Importantly the formulated bioplastic are free from bacterial and fungal contamination during storage. The formulated bioplastic degrade in the environment without causing harmful effect to the environment as it is made by biodegradable polymer and this will be a prominent alternative source to overcome the environmental plastic pollution in the current scenario.

**Keywords:** Bioplastic, Glycerol, PVA, Citric acid, Degradable, Eco-friendly.

## 1. INTRODUCTION

The non degradable plastics are escalating major environmental crises in the recent times. As these plastic residues in landfills degrade very slowly, it causes the original products to remain in our landfills for hundreds or even thousands of years. This accumulation of plastic waste has become a major concern in terms of the environmental pollution (Saharan *et al.*, 2012). The major environmental problem of plastics is that those discarded into land-fills (about 40%) get accumulated in the oceans. Recent studies have shown it to be very toxic for aquatic animals - approximately 43% of marine mammal species, 86% of sea-turtle, 44% of sea-birds which are susceptible to death due to ingestion of marine plastic debris (Agnieszka *et al.*, 2011). Even plastic incineration generates toxic emissions such as carbon dioxide and methane of GHGs (GreenHouse Gases) that contribute to worldwide climatic changes. The Intergovernmental Panel on Climate Change (IPCC) trajectory to 2050 for stabilization of atmospheric GHG concentrations at 450 ppm $CO_2$ requires emissions reduction of 80% compared to the 1990 level. This will be perchance the biggest human challenge for the next generation (Ibrahim Muhammad *et al.*, 2017: EzgiBezirhan *et al.*, 2015).

**Bioplastics**: It moved the government and people to find alternative for the petrochemical derived plastic materials. Biodegradable plastic will be a convenient alternative to petro-plastic as it is derived from renewable sources such as vegetable oil, corn starch, pea starch or micro biota and it delivers a lower carbon footprint (ShanazaKhazir *et al.*, 2014). Bio-plastics are 100% biodegradable, compostable or recyclable. It supports the earth by offering a reduced carbon footprint, reduced use of fossil resource, reduced plastic waste and related environmental problems (Faris *et al.*, 2014). Several research works were needed to fulfill the needs of commercialization and managing the production cost of bio plastic to suitable finding eco-friendly alternative towards plastic use.

**Plant Description:** *T.procumbens* is a widely spread, common weed which grows in the open places, coarse textured soils of tropical regions, sunny dry localities, fields, waste areas, meadows and dunes. It is a semi-prostrate, annual, creeper herb, commonly called 'Wild daisy', 'Mexican daisy' and 'Coat buttons' in English. Its leaves contain phytochemical constituents of 39% of carbohydrates, 17% of fiber, 26% of protein (Satish *et al.*, 2012) and 1.99 g of starch (mg/gm) (Ranjan *et al.*, 2013) and total carbohydrate (5.10±0.02% WW and 51.26±0.20% DW) (Ikewuchi *et al.*, 2009). The leaves of the plant are mainly used for medicinal values as antiseptic to treat wounds, cuts, burns and also as raw feed to cattle and food additive by humans as well. This study focus on the production of bioplastic from plant source polymers of *T.procumbens* leaves which could be non-toxic to the environment and also production with affordable price.

**Figure-1 *Tridax procumbens* plant**

## 2. Experimental section

### 2.1. Collection and Preparation of Leave Sample

The plant specimen was authenticated at BSI (Botanical Survey of India), Coimbatore and its authentication number is BSI/SRC/5/23/2019/248. The leaves of *T.procumbens* were collected from the farm and optimized for suitable preparation of bioplastic. The leaves were washed thoroughly in running water and allowed to shade dry for 2-3 weeks in a clean environment. After drying, the leaves were ground followed by sieving to get rid of coarse particles. The powdered material was stored and used to optimize the bio plastic preparation.

### 2.2 Chemicals

PVA- Polyvinyl alcohol (M.W: 60,000 - 1,25,00 from HIMEDIA Laboratory), Glycerol ($C_3H_8O_3$ M.W: 92.10 from S.D- Fine Chemical Limited), Citric acid, HCl, NaOH.

### 2.3. Bio plastic Synthesis

Using the dried leaf powder, an aqueous extract with Soxhlet apparatus was performed and it was stored in the refrigerator for further use. For the synthesis of bioplastic film, the primary components needed are natural polymer source and plasticizer. Here the natural polymer source was *Tridax procumbens* leaf extract. Plasticizers are the additives that increase the plasticity and flexibility of a material and improve its mechanical property (Akshaya *et al.*, 2019). Commonly used ones are PVA (PolyVinyl Alcohol), Glycerol (Ezeoha *et al.*, 2013; Carlos *et al.*, 2020) and Co- plasticizers/ Secondary additive like Citric acid, water (Zuraida *et al.*, 2012) for bioplastic production.

### 2.4. Preparation of Formulations:

The formulations S-1 prepared by (*T.procumbens* leaf extract with PVA, citric acid, glycerol), S-2 (0.5M HCl treated *T.procumbens* leaf extract with PVA, citric acid, glycerol). The composition of bio plastic with quantity is mentioned in Table 1.After addition of 1% PVA, 1% of glycerol and 1% of citric acid plasticizers to the 25ml of extract, the reaction mixture was heated in a magnetic stirrer for 30 minutes at 60°C to obtain thick gelatinized consistency. The final product was spread evenly on a petriplate / mold and placed in an oven at 65°C for 2 hours to dry. Once it was dried, allowed to cool down and scraped off the bioplastic from the scaffold (Basma *et al.*, 2020).

| Samples | Extract (ml) | PVA (g) | Glycerol (ml) | Citric acid (g) | NaoH, Hcl (ml) |
|---|---|---|---|---|---|
| S-1 | 25 | 2 | 1 | 1 | - |
| S-2 | 25 | 2 | 1 | 1 | 1.5 |

**Table1:Composition of Bioplastic samples**

**2.5 Characteristic of the produced samples**

The samples produced were cut into 1×2 dimension size for each of the following tests. The bioplastic were characterized on the following parameters.

**2.5.1 Transparency and color**

This parameter was determined by visual assessment of the produced bioplastic.

**2.5.2 Flexibility test**

To check for the brittleness or flexibility of the film the thin films were folded horizontally and vertically twice into a small piece and stored for 3 days after which it was unfolded to check for wear and tear or cracks.

**2.6 Biodegradability test:** The Biodegradability test was carried out using the Total Organic Carbon test procedure. To perform the test the samples were cut into small pieces weighing of 0.02 g. Blank tagged as A followed by synthesized bioplastic, polythene and paper were tagged as B, C, D respectively. The samples were put in a tagged conical flask. 10ml of 1 N potassium dichromate ($K2Cr2O7$) was pipetted and added to each of the samples including the blank and swirled. This was followed by addition of 20ml of sulphuric acid to each flask and allowed to cool for about 30 minutes. After that 200ml of distilled water was added to all flasks. 1g of sodium fluoride (NaF) was added to each sample and the blank and allowed to cool for about 15 minutes. Thereafter, 1% of Diphenylamine indicator was added which turned the samples black. Titration of both the samples and the blank was done using 1 N ferrous sulphate solution. Titration of each was stopped when its color changed from black to green and then the values of the titre were recorded (S.L.Ezeoha *et al.*, 2013).

**2.7 Chemical resistance test**

The bioplastic with dimension of 1×2 cm were immersed in various solvents to ascertain their resistance by measuring change in appearance (Jack *et al.*, 2017).

**2.7.1 Determination of the effects of strong acid and base**

The bioplastic were immersed in concentrated hydrochloric acid (0.1M HCl), sodium hydroxide solution (0.1M NaOH) and neutral NaCl solution for 48 hrs and a change in appearance was recorded.

**2.7.2 Determination of the effects of organic solvents**

The organic solvent test was also conducted by immersing the bioplastic in ethanol for 48hours and a change in appearance was recorded.

**2.7.3 Determination of the effects of water**

The bioplastic were immersed in chlorinated water and after a week the changes in appearance was recorded

**2.7.4 Air test**

The bioplastic were exposed to open air for a week and changes in dimension were recorded.

## 3. Results

**3.1 Transparency and Color:** Figure 2 shows the image of bioplastic synthesized (S-1 and S-2) from *T.procumbens* polymer source. The synthesized bioplastic both S-1 and S-2 were transparent and brown color.

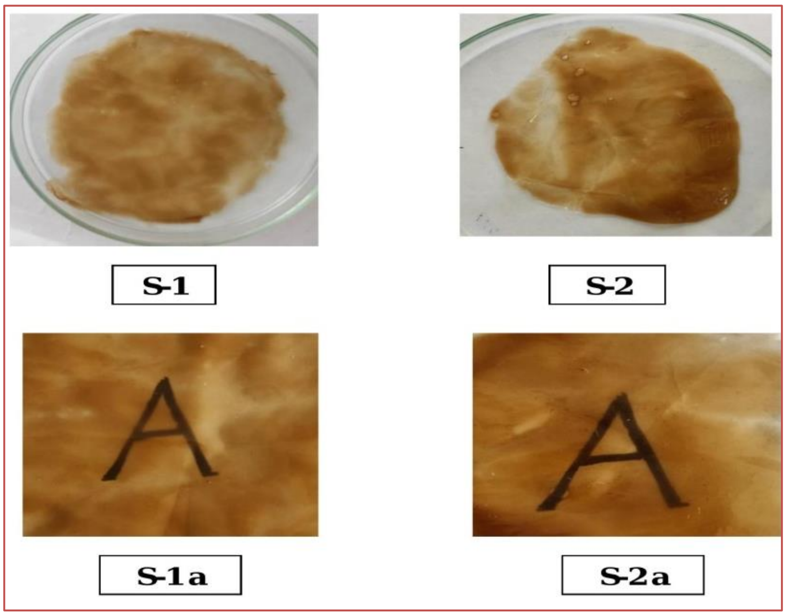


**Figure-2:** Images of synthesized S-1 & S-2 bioplastic color and S-1a & S-2a show the transparency nature of synthesized bioplastic.

**3.2 Flexibility test:** Figure 3 shows the result of flexible nature of the film. No wear and tear or cracks were found in the film even after 3 days of folded nature of the samples.

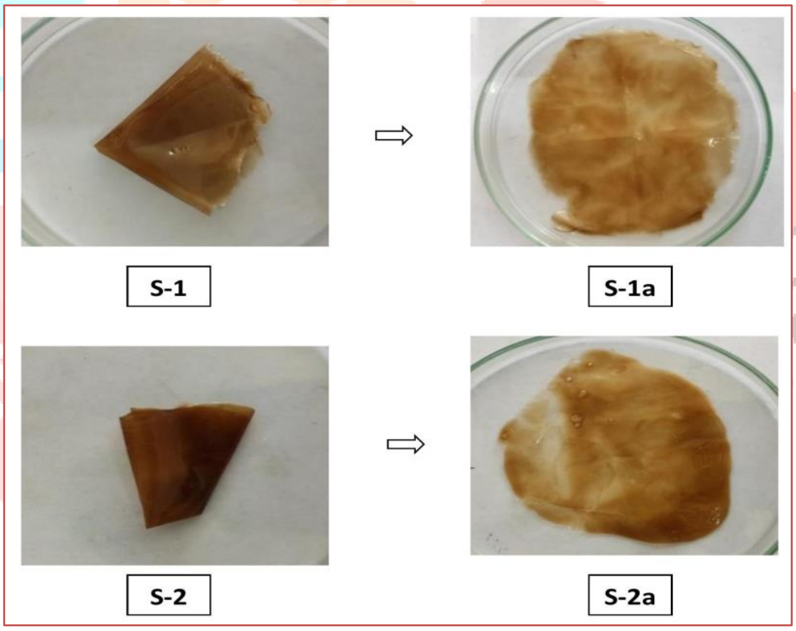


**Figure 3: Images of Bioplastic folded (S-1 & S-2) and unfolded (S-1 a & S-2 a) after 3 days**

**3.3 Biodegradability test:** Table 2 shows the results of biodegradability of samples. Both bioplastic samples results same percentage of organic matter.

| S. No | Sample | | Titre value | Titre difference | % Carbon | %Organic matter |
|---|---|---|---|---|---|---|
| A | Blank | | 13 | - | - | - |
| B | Bioplastic | S-1 | 11 | 2.0 | 39.9 | 68.7 |
| | | S-2 | 11 | 2.0 | 39.9 | 68.7 |
| C | Polythene | | 12.8 | 0.2 | 3.99 | 6.8 |
| D | Paper | | 10.5 | 2.5 | 49.8 | 85.9 |

**Table 2: Total organic carbon test of S-1 and S-2**

(**% of Carbon** = titre difference×0.003×1.33×100/wt, Where, Titre difference= blank titre value – titre value of material; (0.003 equals 1N potassium dichromate=3mg carbon, 1.33 equals correction factor, Wt= weight of sample= 0.02g each)

**% organic matter** = % carbon × 1.724, Where 1.724 is from relationship; 100g of carbon=58 of organic matter)

### 3.4 Chemical resistance test

Results of Chemical resistance of the samples S-1 and S-2 in various solvent are presented in Table 3 below.

| Solvent | Resistance | | | |
|---|---|---|---|---|
| | S-1 | | S-2 | |
| | Change in dimension | Dissolved in liquid/ solution | Change in dimension | Dissolved in liquid/solution |
| 0.1M HCl | + | - | + | - |
| 0.1M NaOH | + | - | + | - |
| NaCl solution | - | - | - | - |
| 50% Ethanol | - | - | - | - |
| Water | + | + | + | + |
| Air | - | - | - | - |

**Table 3: S-1 and S-2 chemical resistant activity**

**("+" indicates yes & "-" indicates no)**

## 4. Discussion

Most of the natural polymers were incorporated with PVA type of water soluble synthetic biodegradable polymer to obtain better mechanical property (Laxmeshwar *et al.*, 2012; Juliano *et al.*, 2017) and promising application for packaging material (Mandala *et al.*, 2020) Thus, in the current study, *T.procumbens* leaf extract with PVA plasticizer showed good characteristic nature. Similar to the present study, Zhijun Wu *et al*. (2017) also prepared the film by addition of PVA, citric acid, glycerol by using (1-2.8 g) of corn starch as polymer source which showed good composite nature for food packaging application.

*T.procumbens* bioplastic produced were characteristically transparent, brown in color and flexible in nature. S-1 was prepared without HCl treatment, S-2 was prepared by treatment of leaf extract with 0.5N HCl for hydrolysis purpose; the reaction of starch with hydrochloric acid breaks down the amylopectin as it inhibits the formation of bioplastic (Noor Fatimah *et al.*, 2017). Compared to S-1, S-2 showed a glossy nature, an additional characteristic on the surface of the film. Other than that, no significant characteristic change was observed in the film. Both the samples did not dissolve in ethanol but it dissolved in water because of the addition of PVA as it is soluble in water and insoluble in organic solvents like ethanol. S-1 and S-2 showed 68% of organic matter and 40% of carbon, thus it was biodegradable in the environment as it consists of more than 50% of organic matter. Air test showed no changes in dimension of S-1 and S-2 when it was exposed to open air environment. Flexibility test showed that S-1 and S-2 remained same in nature without wear and tear or crack in the film. It showed that it can be folded into any dimension for packaging application.

Both the samples were checked after one month of storage in room temperature at 37$^{o}$C and found to have no changes in bioplastic nature, no bacterial or fungal contamination, no cracks in the film.

## 4. Conclusion

The negative carbon footprint and long-term environmental effects of fossil-based plastics through landfill and incineration paved way for the search of new alternative plastic material. In the current study, we have identified a candidate source for the synthesis of bioplastic material using a weed plant, namely *T.procumbens* polymers which is eco-friendly and economical. Non-degradable plastics can be easily replaced by this source after the confirmation that it is not harmful or toxic when used by human beings. Such alternative sources would naturally bring down the disastrous environmental pollution by plastic and make the world a greener and cleaner place to live.

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## 6. Reference

1. S.L.Ezeoha, J.N.Ezenwanne. 2013. Production of biodegradable plastic packaging film from Cassava starch. IOSR J.Enginn, 3(10): 14-20.
2. Noor Fatimah Kader Sultan, Wan Lutfi Wan Johari. 2017. The development of Banana peel/ Corn Starch Bioplastic Film: A Preliminary study. Bioremediation Sci& Tech Res. 5(1): 12-17.
3. Satish ABhalerao, Tushar S Kelkar. 2012. Phytochemical & Pharmacological potential of Tridaxprocumbens L. Int J Advanced Bio Res, 2(3): 392-395.
4. Ranjan R, Patil V.N, Joshi A R, Kamble S R, Charudhary V R,Deokule S S. 2012. Pharmacognostic and phytochemical screening of leaves and stem of Tridax procumbens Linn, Int. J Of Current Res, 5(2): 328-331.
5. EzgiBezirhanArikan & HavvaDuyguOzsoy.2015. A Review: Investigation of Bioplastics, J. Civil Engin& Architecture, 9: 89-92.
6. Faris N A, Noriman N Z & Sam S T .2014. Current Research in Biodegradable plastic. App.Mech&Mat., 679: 273-280, https:// doi.org/10.4028/www.scientific.net/AMM.679.273.
7. Saharan B.S, Ankita & Deepansh Sharma. 2012. Bioplastics-For Sustainable Development: A Review. Int. J. of Microbial Resource Tech, 1(1): 11-23.
8. ShanazaKhazir ,Sneha Shetty .2014. Bio-based polymers in the world. Int. J. Life Sc. Bt & Pharm. Res., 3(2): 35-43.
9. Ibrahim Muhammad Shamsuddin , Jafar Ahmad Jafar, AbubakarSadiq Abdulrahman Shawai,Saleh Yusuf, Mahmud Lateefah, Ibrahim Aminu. 2017. Bioplastics as Better Alternative to Petroplastics and Their Role in National Sustainability: A Review. Advances in Biosci& Bioengineering., 5(4):63-70.
10. Basma Y.Alashwal, Mohamed Saad Bala, Arun Gupta, Swati Sharma, Puranjan Mishra .2020. Improved properties of Keratin-based bioplastic film blended with microcrystalline cellulose: A comparative analysis. J. King Saud Uni-Sci, 32: 853-857.
11. Zuraida A, Ysuliza Y, Anuar H, Mohd Kharirul Muhaimin R. 2012. The effect of water and citric acid on sago- starch bio-plastics, Int. Food Res. J ,19 (2): 715-719.
12. Akshaya Krishnamurthy, Pavithra Amritkumar .2019. Synthesis and Characterization of eco-friendly bioplastic from low-cost plant resources, SN Applied Sci, 1:1432.
13. Ikewuchi Jude C, Ikewuchi Catherine C, M.Igboh Ngozi. 2009. Chemical Profile of Tridax procumbens Linn, Pakistan J of Nutri, 8(5):548-550.
14. S.L.Ezeoha, J.N.Ezenwanne .2013. Production of biodegradable plastic packaging film from Cassava starch. IOSR J.Enginn. 3(10): 14-20.
15. Carlos Alberto Gomez-Aldapa, Gonzalo Velazquez,Miguel C.G, Esmeralda Rangel- Vargas,Javier Castro-Rosas,Rocio Yaneli Aguirre- Loredo (2020). Effect of polyvinyl alcohol on the physiochemical properties of Biodegradable starch films, Materials Chemistry and Physics, 239
16. Zhijun Wu, Jingjing Wu, Tingting Peng, Yutong Li, Derong Lin, Baoshan Xing, Chunixao Li, Yuquiu Yang, Li Yang, Lihua Zhang, Rongchao Ma, Weixiong Wu, Xiaorong Lv, Jianwu Dai, Guoquan Han. 2017. Preparation and Application of Starch/Polyvinyl Alcohol/Citric acid Ternary Blend Antimicrobial Functional Food Packaging Films, Polymers., 9,102.
17. Lameshwar S.S, Madhu Kumar D.J, Viveka S, Nagaraja G.K. 2012. Preparation and properties of Biodegradable film Composites using Modified Cellulose Fibre-reinforced with PVA, Int.Scho.Res.Network ( ISRN Polymer Science) ,doi:10.5402/2012/154314.

18. Juliano Zanela, Maira Casagrande, Monica Oliveira Reis, Maria Victoria Eiras Grossmann, Fabio Yamashita. 2017. Biodegradable Sheets of Starch/Polyvinyl Alcohol (PVA): Effects of PVA Molecular Weight and Hydrolysis degree. Water Biomass Valo., Doi 10.1007/s12649-017-0051-6.

19. Jack IR, Ngah SA, Osagie OF,Emenike IG .2017. Biodegradable plastic from renewable source. Int J Emerg Trends Technol Comput Sci 4(6): 5293-5300.

20. Mandala W C R, Saepudin E, Nizardo N M. 2020. Effect of addition of antibacterial compound from Kelor leaves extract (Moringa oleifera Lam) to foodborne pathogen bacteria activity on crosslinked bioplastic polyvinyl alcohol/ starch. AIP Conference Proceedings: 2242, 040042; https://doi.org/10.1063/5.0010360.