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Original Research

Valorization of Corn Cob into Cellulose-Based Bioplastics: Extraction, Fabrication and Biodegradability Evaluation

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ABSTRACT

The increasing production, consumption, and improper disposal of petroleum-based plastics are causing environmental degradation. A sustainable and environmentally friendly alternative to resolve the synthetic plastic-based problem is bioplastic. Agricultural waste, rich in cellulose, can be used as a raw material for bioplastic production and supporting circular economy goals. The purpose of the current study is to isolate cellulose from corn cob using alkali and bleaching treatment, and its utilization in the synthesis of bioplastic. The study also incorporates the sensory evaluation, thickness test, and fourier transform infrared (FTIR) spectroscopy characterization. Further, the prepared bioplastic was tested for biodegradability. The yield of extracted cellulose was 53.1±0.7%. Bioplastic was successfully prepared using the solvent casting method, which was confirmed by FTIR analysis. The range of thickness was between 0.37±0.07 mm-0.45±0.06 mm. The degradation period was observed to be 21 days to 35 days. This study promotes the effective valorisation of agricultural residue corn cob and proposes an environmentally responsible waste management strategy. The prepared bioplastic may prove beneficial in packaging applications, leading to reduced reliance on fossil fuels and environmental pollution.

INTRODUCTION

Plastic is unmatched because of its qualities and is used daily to prepare many key commodities from textiles and pharmaceuticals to industrial manufacturing, packaging, and agricultural mulch production (Ghasemlou et al. 2022; Kumari et al. 2023). Over the past ten years, the world's consumption of synthetic plastics has grown significantly due to their better performance and low cost. However, the widespread usage of plastic products and the disposal of these materials have resulted in considerable toxicity (Brodin et al. 2017), and many nations acknowledge plastic pollution as a serious environmental issue (Ghasemlou et al. 2022). Many methods, such as recycling and burning, are already employed to treat plastic trash; however, they have not been able to address or reduce the environmental issues brought on by plastic pollution (Sardon & Dove 2018). Because of its non-biodegradable nature and difficulty in recycling, there are serious concerns for human health and the environment (Kowser et al. 2025). The release of harmful gases and other toxic compounds during the production and disposal of plastic waste causes air and water pollution (Adekanmbi et al. 2024). Accumulation of microplastics and leaching of harmful chemicals present in plastic waste results in soil pollution (Li et al. 2024). Plastic contains additives like phthalates and bisphenols, these additives cause serious health effects like reproductive disorders, endocrine disruption, diabetes, and cardiovascular diseases. Ingestion or inhalation of microplastics results in digestive and respiratory disorders (Naidoo & Rajkaran 2020; Kawa et al. 2021).

Thus, global regulations about plastic use highlight the need for innovative materials that ensure food safety, maintain quality, and protect the environment (Kowser et al. 2025). Bioplastics (BP) are gaining popularity as a biodegradable substitute for petroleum-based plastics and have the potential to significantly lower environmental plastic pollution (Ahsan et al. 2023). They are mostly made of renewable resources like starch, cellulose, proteins, and so forth (Wicaksono et al. 2022). Bioplastic can be prepared from agricultural waste using various processes, such as acidification, hydrolysis, and microbial fermentation (Babu et al. 2013; Sahin et al. 2021). Their special qualities, including their low cost, nontoxicity, biodegradability, biocompatibility, and ability to produce thermoplastic items, guarantee a substantial contribution to sustainable development (Ghasemlou et al. 2022). Various microorganisms can enzymatically break down bioplastics into environmentally benign inorganic chemicals or biomass (Silva et al. 2023). This is frequently followed by microbes assimilating and mineralizing the polymer fragments, producing mineral salts, carbon dioxide, water, methane, and biomass (Lv et al. 2017).

Starch based bioplastics are very popular in the market and are produced using different sources (European Bioplastics, 2021). A number of research studies have been carried out on bioplastic production using starch. Kulshreshtha et al. (2017) created a building material based on maize starch. Zakaria et al. (2018) prepared the potato starch film using a glycerol as plasticizer with the help of solution casting method. Borges et al. (2015) examined the characteristics of biodegradable films made from various starch sources by varying the plasticizers. Kowser et al. (2025) prepared corn starch-based BP with glycerol and vinegar. Despite having high processing capabilities, starch-based BP are not suited for most common uses due to several drawbacks, including their inherent hygroscopic nature and poor mechanical performance, low thermal stability as compared to traditional petroleum-based bioplastics (Jahwari and Pervez 2019; Kaboorani et al. 2021), which also restricts their use in various industries.

Another most prevalent biopolymer, cellulose, is used in papermaking, textiles, and bioplastics. Wood, cotton, and agricultural waste are renewable plant sources from which cellulose is obtained (Wadukar et al. 2024). While cellulose and starch share a monomer unit, their polymeric chains are oriented differently (Qasim et al. 2021). The functional properties of the starch-based bioplastic can be improved by the amendment of cellulose (Cheng et al. 2021; Raza et al. 2023). Corn cob, an agricultural residue, consists of three tissues: chaff, woody ring, and pith, and structurally supports the kernels. Approximately 1.2 billion tonnes of maize (corn) were produced worldwide, ranking second to sugarcane (FAOSTAT, 2023) and thus a large amount of corn cob is also produced. Being locally available, corn cobs can be used as a low-cost material to isolate cellulose. As corn cob remains underutilised, the current study focuses on examining its potential as a sustainable and renewable raw material for bioplastic synthesis.

The objectives of this study include isolating cellulose from agroresidue corn cob and its successful inclusion in preparing bioplastic. The prepared bioplastic was characterized using FTIR, a thickness test, and a sensory evaluation was performed. A biodegradability test was performed to analyse whether the prepared bioplastic degrades under natural conditions and the time taken.

2. MATERIALS AND METHODS

Materials

Corn cob was collected from a local sweet corn (*Zea mays L.*) seller near Maharshi Dayanand University, Rohtak. Sodium hypochlorite and sodium hydroxide were provided by Loba Chemie and CDH, respectively. Glycerol, used as a plasticizer, was supplied by CDH. All chemical compounds used in this experimental study were of analytical grade.

Isolation of cellulose from Corncob

For cellulose isolation, the collected corn cobs were washed to remove dirt and impurities, followed by sun drying. Further, the corn cobs were cut into small pieces, ground into fine powder, and sieved using a sieve of mesh size 0.2 mm. Corn cob powder was dewaxed using a solution of ethanol and deionised water in 1:1 v/v for four hours, then boiling the mixture for 1.5 hours, followed by multiple washes with distilled water and oven drying. 10 g of dewaxed corn cob was treated with 200 ml of 5% NaOH solution for two hours and washed to remove the remaining alkali. The alkali-treated corn cob was then bleached using a 1.5% NaOCl solution for half an hour, and then it was washed until a neutral pH was achieved. The extracted cellulose sample was oven-dried for 16 hours at 50°C, then crushed into a fine powder, and stored in ziplock bags (Ungprasoot et al. 2021; Melesse et al. 2022; Khiewsawai et al. 2023). Fig. 1 shows the process of extracting cellulose from corn cobs.

Cellulose yield was calculated using Eq. (1).

$$Yield\ (\%) = \frac{W2}{W1} x100 \tag{1}$$

Where W1= = Initial weight of corn cob powder, and W2 = Final weight of extracted cellulose.

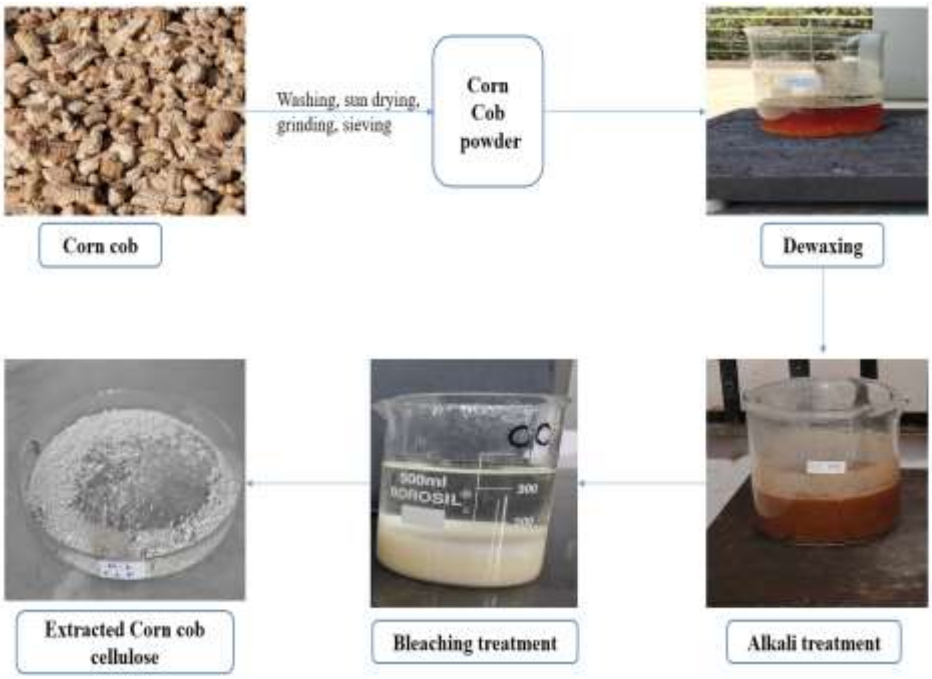

Fig. 1 Schematic of Cellulose Extraction from Corn Cob Using Alkali Treatment and Bleaching.

Synthesis of Bioplastic

Three bioplastics with different ingredient percentages were created, as indicated in Table 1, and were labelled as CCB (Corncob cellulose bioplastic). An electronic weight scale is used to carefully and precisely weigh each ingredient. The bioplastic was prepared using the solvent casting method; for this, distilled water and starch were mixed and heated until the starch gelatinized. Then glycerol and corn cob cellulose were added, and the mixture was heated at 65°C for half an hour with continuous stirring to avoid clumping. The prepared filmogenic solution was uniformly spread on a silicon sheet and oven dried at 60°C for 7-9 Hours (Chowdhury et al. 2022). The method of bioplastic synthesis is illustrated in Fig. 2.

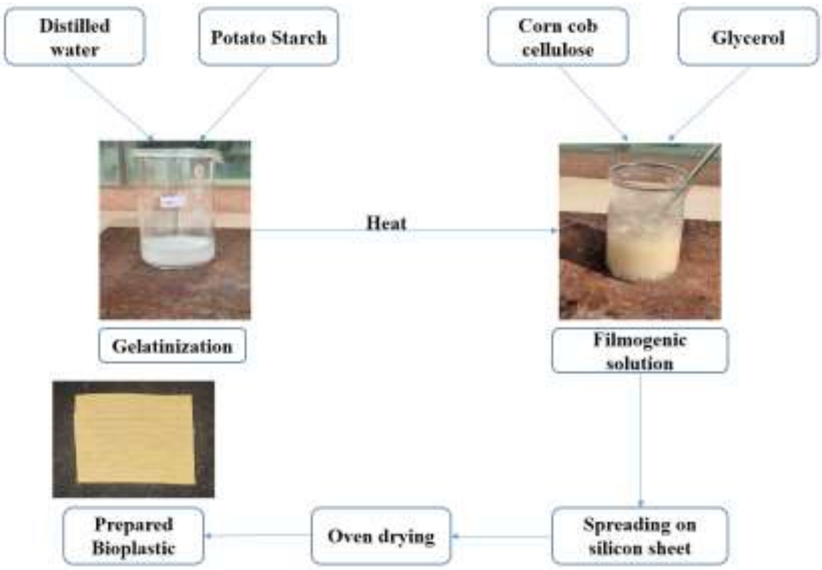

Fig. 2 Process Flow for the Preparation of Bioplastic Using Extracted Cellulose.

Table 1. Ingredients and Their Proportions in Bioplastic Samples.

Bioplastic Sample	Corn cob cellulose (%)	Starch (%)	Glycerol (%)	Distilled water (%)
CCB1	5	5	3	87
CCB2	10	5	3	82
CCB3	15	5	3	77

Characterization

Sensory evaluation of prepared bioplastic

Bioplastic films were examined for cracks, color, texture, and overall appearance during the sensory evaluation. These characteristics are crucial since they significantly impact how good is the final product.

Thickness

Each film's thickness was measured using an electronic digital caliper at three randomly chosen locations (Admase et al. 2022). The average film thickness was determined.

FTIR

The examination of a wide range of materials, including polymers, inorganic chemicals, and organic molecules, is frequently done using the Fourier transform infrared spectroscopy (FTIR). It includes using infrared light to detect the samples and tracking variations in the absorption bands, which yield important details regarding the materials' composition. The sample is exposed to a range of infrared radiation during the examination; while some of the radiation passes through, some is absorbed by the sample. The sample transforms the absorbed radiation into rotational and vibrational energy. Fourier transform infrared (FTIR) spectroscopy was used to examine the functional groups. Bruker's Invenio ® FTIR spectrometer was employed in the current study.

Biodegradability Test

The prepared bioplastic samples were cut into square shapes, weighed 0.5 g, and buried under soil. The films were checked at 7 days, 14 days, 21 days, 28 days, and 35 days. An accurate electronic balance was used to measure the initial and final weights (Chowdhury et al. 2022). Garden soil was used for this experiment. The pH, temperature, and moisture content of the soil during the biodegradation test were maintained at 7, 35°C, and 50%, respectively. An LDPE plastic bag was taken as a control. Eq (2) was used to determine the film's biodegradability.

$$\text{Biodegradation (\%)} = W3 - W4/W3 \times 100 \quad (2)$$

Here, W3 = the bioplastic sample's initial weight.

W4 = the bioplastic sample's final weight.

The statistical significance of degradation across various samples and time periods was evaluated using one-way ANOVA, which was followed by Tukey's test (for inter-group comparisons) and Dunnett's test (for comparison with control).

3. RESULTS AND DISCUSSIONS

3.1. Cellulose Yield

The experiments were conducted in triplicate, and the cellulose yield is shown as their means and standard deviation. The yield of cellulose extracted from corn cob in the present study was 53.1±0.7%. Wakudkar et al. (2025) found that the amount of cellulose in corn cob biomass is 42.3%. Thus, the yield of cellulose in the present study is 10.8% higher than that of corn cob biomass. However, using alkali and bleaching treatment, they isolated 88.13% cellulose, which is comparatively higher. Kapdi et al. (2024) used akali pretreatment and acid and bleaching pretreatment to obtain highly purified cellulose from rice straw, and the yield was 58%, higher than the yield in the present study. Sinaga et al. (2014) extracted 17.4% of cellulose, which is lower than the current study. Overall, the yield of cellulose was found to lie within the range of previous literature.

3.2. Sensory evaluation

Sensory evaluation of bioplastic films analysed the texture, physical appearance, and color (Table 2). Control (LDPE) was transparent and aroma-free. Apart from control, all three bioplastic films were also free from any kind of smell. The colour of these films varied from pale white to creamish yellow. CCB1 (5% cellulose) was pale white in colour, possibly due to the low concentration of cellulose. CCB2 (10% cellulose) and CCB3 (15% cellulose) were creamish to creamish yellow, respectively. This can be attributed to the high cellulose content used for their preparation. CCB1 and CCB2 exhibited smooth texture, whereas CCB3 had one smooth surface and the other slightly stiff and grainy.

Overall, the work was in harmony with other researchers who worked on similar material. Azmin et al. (2022), also observed that a higher amount of kenaf resulted in the formation of darker bioplastic. In the work of Azmin et al. (2020), colour varied from brown to greenish grey, and they also observed that the color darkens with the rising concentration of cellulose. Apart from this, they noticed a sweet smell in the bioplastic, which was absent in the present study.

Table 2. Sensory Evaluation Results of Control and Bioplastic Samples.

Sample Codes	**Control**	**CCB1**	**CCB2**	**CCB3**
Physical Appearance				
Color	Transparent	Pale white	Creamish	Creamish yellow
Texture	Smooth	Smooth	Smooth	Slightly hard and grainy
Smell	Absent	Absent	Absent	Absent

3.3. Thickness

The thicknesses of CCB1, CCB2, CCB3, and control were found to be 0.37±0.07 mm, 0.39±0.02 mm, 0.45±0.06 mm, and 0.12±0 mm, respectively, as shown in Fig. 3. All the samples exhibited a thickness higher than the control. A minimum thickness of 50 µm is prescribed by the government of India under the Plastic Waste Management Rules, 2016, for packaging material. All the prepared samples exhibited a thickness higher than 50 µm. Thus, it can be said that the prepared bioplastic passes the thickness criteria for packaging films (Marichelvam et al. 2019).

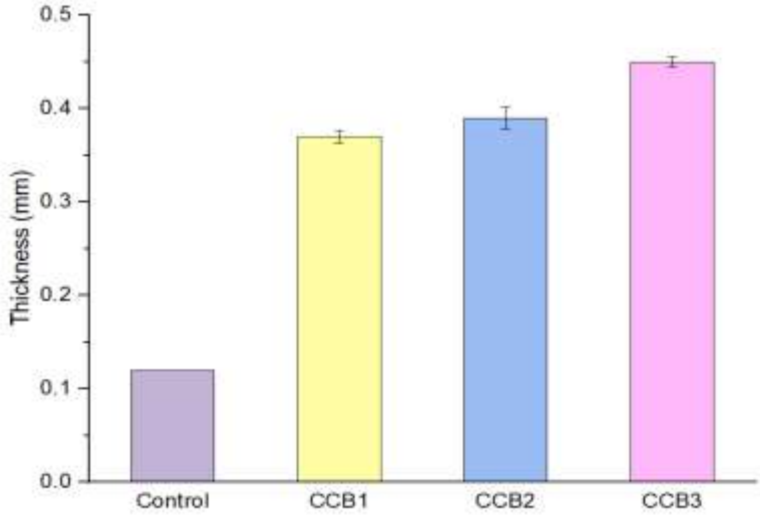

Fig. 3 Thickness Test Results of Control and Prepared Bioplastics.

Marichelvam et al. (2022) prepared bioplastic using *Prosopis juliflora* with a thickness of 390 µm. In another study, corn starch and rice starch were used for bioplastic preparation, and the prepared films had a thickness of 250 µm. A study by Oluwasina et al. (2024) and Majamo and Amibo (2024) showed that the thickness of bioplastic ranged from 0.21 mm to 0.48 mm and 0.410 mm to 0.421 mm, respectively. The thickness of bioplastic in the current study increases with cellulose concentration. This observation was in harmony with the previous literature. Overall, the thickness is affected by the viscosity of the prepared solution, the casting mould, and the concentration of cellulose.

3.4. Fourier Transform Infrared (FTIR) spectroscopy

The chemical structure of the prepared bioplastic was characterized by Fourier Transform Infrared (FTIR) spectroscopy, and the resulting spectrum is shown in Fig. 4. The FTIR analysis revealed several characteristic absorption bands corresponding to the functional groups of cellulose, starch, and glycerol, indicating successful blending of these components. A broad and intense peak was observed at 3333 cm^{-1}, corresponding to the O–H stretching vibrations of hydroxyl groups commonly present in cellulose, starch, and glycerol. This suggests the formation of a strong hydrogen-bonding network within the bioplastic matrix (Majamo and Amibo 2024). The peak at 2921 cm^{-1} was assigned to the C–H stretching vibrations of aliphatic $–CH_2$ groups from the polysaccharide backbone and glycerol molecules (Oluwasina et al. 2024).

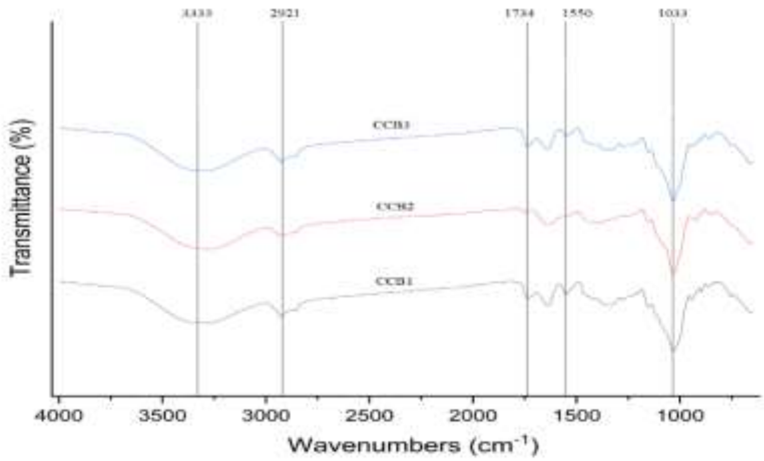

Fig. 4 FTIR Analysis of Bioplastics Prepared from Corn Cob-Derived Cellulose.

An absorption band at 1734 cm^{-1} was attributed to C=O stretching vibrations, indicating the presence of carbonyl groups. This may suggest partial esterification or interaction between glycerol and the hydroxyl groups of polysaccharides during bioplastic formation (Majamo and Amibo 2024; Chowdhury et al. 2022). A band at 1550 cm^{-1} was associated with the cyclic alkene C-C stretch. Furthermore, the peak at 1033 cm^{-1} was attributed to the aliphatic ether stretch (Bhutta et al. 2022). Overall, the FTIR results confirm the successful incorporation of cellulose, starch, and glycerol without significant chemical modification, indicating that the bioplastic primarily relies on physical blending and hydrogen bonding for structural integrity.

3.5. Biodegradability Test

The results highlighted that CCB1 and CCB3 showed the lowest and highest degradation times of 21 days and 35 days, respectively. The degradation period for CCB2 was found to be 28 days. The percent weight loss at different time intervals is shown in Fig. 5. Results of the statistical analysis revealed that there was a significant difference ($p \leq 0.05$) in the degradation of all bioplastic samples as compared to control. A significant difference ($p \leq 0.05$) was also observed in the weight loss (%) among day 7, day 14 and day 21, highlighting that the degradation of bioplastic is enhanced with the passage of time. Meanwhile, no significant difference was observed between day 28 and day 35. These results imply that significant deterioration occurred over the first 21 days, reaching total (100%) degradation by Day 35.

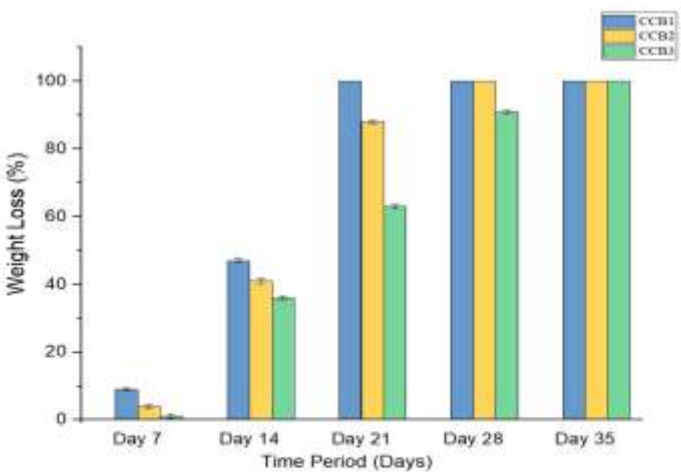

Fig. 5 Weight Loss (%) of Bioplastic Samples During Biodegradation Over Time.

It is evident from the findings that there is a noticeable increase in the rate of degradation with an increase in time. The rate of degradation is highly affected by the concentration of cellulose used. The present work is consistent with Kowser et al. 2023, who observed the same. Apart from this, the moisture content and addition of glycerol enhanced the process of degradation of bioplastics (Sultan et al. 2024). Fig. 6 depicts the different stages of bioplastic degradation. In the initial phase, i.e., the first seven days, no significant mass loss was observed. This can be attributed to the adaptability the microorganism requires to synthesize specific enzymes required for bioplastic degradation (Pathak and Navneet 2017; Chowdhury et al. 2022).

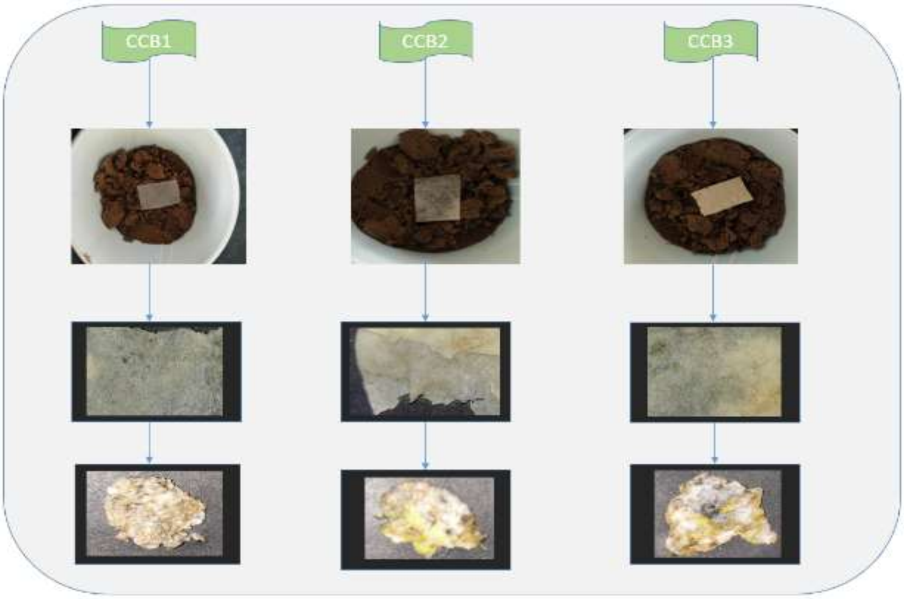

Fig. 6 Visual Appearance of Bioplastic Samples at Different Stages of Biodegradation

Chowdhry et al. (2022) observed that mass loss % increased from 36% to 50% for two different bioplastic samples in a duration of 7 days to 30 days. Marichelvam et al. (2019) depicted a 48.73% degradation rate in 15 days for a corn and rice starch-based bioplastic. The corn starch-based samples degraded completely in 28 days, with a % mass loss increase from 34.3% to 74.3% in 21 days (Rajesh et al. 2024). Similar results have been reported by (Stefani et al. 2006; Kammoun et al. 2013; Pathak and Navneet, 2017; Briones et al. 2020; Razak et al. 2020; Kowser et al. 2025). No significant weight loss was observed in the control and all the bioplastic films were completely biodegradable within 35 days.

4. CONCLUSIONS

Bioplastic films were prepared efficiently using potato starch and cellulose extracted from corn cob, with the inclusion of glycerol as a plasticizer, and their properties were evaluated. The colour of prepared films varied from pale white to creamish yellow, and they were aroma-free. FTIR analysis also revealed that cellulose, starch, and glycerol were successfully incorporated into the bioplastic. The major peaks were found at 3333 cm^{-}, 2921 cm^{-1}, 1734 cm^{-1}, 1550 cm^{-1} and 1033 cm^{-1}, indicating the presence of cellulose, starch, glycerol, and water content in the prepared films. Further, soil burial method for biodegradation test showed that all the prepared bioplastics underwent biodegradation and were completely biodegradable within 21 to 35 days. By converting waste into value-added bioplastics, the study supports the concept of a circular economy and provides a green alternative to conventional plastics. The developed bioplastic holds market potential in eco-friendly packaging applications. Further research should be carried out to improve the mechanical and physical properties of bioplastic.

Author Contribution: This study was a collaborative effort from all authors. **Shikha Kumari** conceptualized and designed the study, performed the experiments, and prepared the initial draft of the manuscript. **Alka Rao** provided critical feedback and suggestions on the manuscript draft. **Dr. Manjeet Kaur** and **Dr. Geeta Dhania** thoroughly reviewed the manuscript, offered valuable insights, and finalized the paper for submission. All authors read and approved the final version of the manuscript.

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Conflict of Interest: The authors declare that they have no competing interests.

REFERENCES

Admase, A. T., Sendekie, Z. B., & Alene, A. N. (2022). Biodegradable Film from Mango Seed Kernel Starch Using Pottery Clay as Filler. *Journal of Polymers and the Environment*, *30*(8). https://doi.org/10.1007/s10924-022-02449-7

Adekanmbi, A. O., Ani, E. C., Abatan, A., Izuka, U., Ninduwezuor-Ehiobu, N., & Obaigbena, A. (2024). Assessing the environmental and health impacts of plastic production and recycling. *World Journal of Biology Pharmacy and Health Sciences*, *17*(2), 232-241.

Ahsan, W. A., Hussain, A., Lin, C., & Nguyen, M. K. (2023). Biodegradation of Different Types of Bioplastics through Composting—A Recent Trend in Green Recycling. In *Catalysts* (Vol. 13, Issue 2). https://doi.org/10.3390/catal13020294

Al-Jahwari, F. S., & Pervez, T. (2020). The Potential of Environmental-Friendly Biopolymers as an Alternative to Conventional Petroleum-Based Polymers. In *Encyclopedia of Renewable and Sustainable Materials: Volume 1-5* (Vols. 1–5). https://doi.org/10.1016/B978-0-12-803581-8.11295-0

Azmin, S. N. H. M., & Nor, M. S. M. (2020). Development and characterization of food packaging bioplastic film from cocoa pod husk cellulose incorporated with sugarcane bagasse fibre. *Journal of Bioresources and Bioproducts*, *5*(4), 248-255.

Azmin, S. N. H. M., Sharif, N. S. E. M., Nor, M. S. M., Abdullah, P. S., & Iwansyah, A. C. (2022). Processing and Characterization of Bioplastic Film Fabricated from a hybrid of Cocoa Pod Husk and Kenaf for the Application in Food Industries. *Agriculture Reports*, *1*(1).

Babu, R. P., O'Connor, K., & Seeram, R. (2013). Current progress on bio-based polymers and their future trends. *Progress in Biomaterials*, *2*(1). https://doi.org/10.1186/2194-0517-2-8

Bhutta, M. S., Xuebang, T., Akram, S., Yidong, C., Ren, X., Fasehullah, M., ... & Nazir, M. T. (2022). Development of novel hybrid 2D-3D graphene oxide diamond micro composite polyimide films to ameliorate electrical & thermal conduction. *Journal of Industrial and Engineering Chemistry*, *114*, 108-114.

Borges, J. A., Romani, V. P., Cortez-Vega, W. R., & Martins, V. G. (2015). Influence of different starch sources and plasticizers on properties of biodegradable films. *International Food Research Journal*, *22*(6).

Briones, M. F., Jazmin, P. F., Pajarillaga, B. E., Juvinal, J. G., de Leon, A. A., Rustia, J. M., & Tuates, A. M. (2020). Biodegradable film from wild taro colocasia esculenta (L.) schott starch. *Agricultural Engineering International: CIGR Journal*, *22*(1).

Brodin, M., Vallejos, M., Opedal, M. T., Area, M. C., & Chinga-Carrasco, G. (2017). Lignocellulosics as sustainable resources for production of bioplastics – A review. In *Journal of Cleaner Production* (Vol. 162). https://doi.org/10.1016/j.jclepro.2017.05.209

Cheng, H., Chen, L., McClements, D. J., Yang, T., Zhang, Z., Ren, F., Miao, M., Tian, Y., & Jin, Z. (2021). Starch-based biodegradable packaging materials: A review of their preparation, characterization and diverse applications in the food industry. In *Trends in Food Science and Technology* (Vol. 114). https://doi.org/10.1016/j.tifs.2021.05.017

Chowdhury, M. A., Hossain, N., Noman, T. I., Hasan, A., Shafiul, A., & Mohammod Abul, K. (2022). Biodegradable, physical and microbial analysis of tamarind seed starch infused eco-friendly bioplastics by different percentage of Arjuna powder. *Results in Engineering*, *13*. https://doi.org/10.1016/j.rineng.2022.100387

Dabhade, G., Daware, G., Rajesh, Y., Jeeru, L. R., Sangle, S., Shelke, Y., & Borhade, A. V. (2023). Ecofriendly synthesis of pure and modified CuMnO3: It's application as gas sensor. *Materials Today: Proceedings*, *77*, 39-44.

European Bioplastics, & Nova-Institute. (2021). Bioplastics Market Development Update 2021. *European Bioplastics Org.*, *2021*.

FAOSTAT (2019) Data

Ghasemlou, M., Daver, F., Murdoch, B. J., Ball, A. S., Ivanova, E. P., & Adhikari, B. (2022). Biodegradation of novel bioplastics made of starch, polyhydroxyurethanes and cellulose nanocrystals in soil environment. *Science of the Total Environment*, *815*. https://doi.org/10.1016/j.scitotenv.2021.152684

Kaboorani, A., Gray, N., Hamzeh, Y., Abdulkhani, A., & Shirmohammadli, Y. (2021). Tailoring the low-density polyethylene - thermoplastic starch composites using cellulose nanocrystals and compatibilizer. *Polymer Testing*, *93*. https://doi.org/10.1016/j.polymertesting.2020.107007

Kammoun, M., Haddar, M., Kallel, T. K., Dammak, M., & Sayari, A. (2013). Biological properties and biodegradation studies of chitosan biofilms plasticized with PEG and glycerol. *International Journal of Biological Macromolecules*, *62*. https://doi.org/10.1016/j.ijbiomac.2013.09.025

Kawa, I.A., Fatima, Q., Mir, S.A., Jeelani, H., Manzoor, S. & Rashid, F. (2021). Endocrine disrupting chemical Bisphenol A and its potential effects on female health. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 15(3), 803-811.

Kowser, M. A., Mahmud, H., Chowdhury, M. A., Hossain, N., Mim, J. J., & Islam, S. (2025). Fabrication and characterization of corn starch based bioplastic for packaging applications. *Results in Materials*, *25*, 100662.

Khiewsawai N, Rattanawongwiboon T, Ummartyotin S (2024) Cellulose fiber derived from sugarcane bagasse and polyethylene glycol/acrylic acid/branched polyethylenimine-based hydrogel composite prepared by gamma irradiation: A platform for mercury (II) ions adsorption. Environ Adv 17:100561. https://doi.org/10.1016/j.envadv.2024.100561

Kapdi D, Bhavsar N, Rudakiya D (2024) Developing sustainable and energy efficient process to obtain high purity cellulose and its value-added chemicals from rice straw. Bioresour Technol Rep 25. https://doi.org/10.1016/j.biteb.2023.101732

Kulshreshtha, Y., Schlangen, E., Jonkers, H. M., Vardon, P. J., & van Paassen, L. A. (2017). CoRncrete: A corn starch based building material. *Construction and Building Materials*, *154*. https://doi.org/10.1016/j.conbuildmat.2017.07.184

Kumari, S., Rao, A., Kaur, M., & Dhania, G. (2023). Petroleum-Based Plastics Versus Bio-Based Plastics: A Review. *Nature Environment & Pollution Technology*, *22*(3).

Li, Y., Liu, C., Yang, H., He, W., Li, B., Zhu, X., ... & Tang, K. H. D. (2024). Leaching of chemicals from microplastics: A review of chemical types, leaching mechanisms and influencing factors. *Science of the Total Environment*, *906*, 167666.

Lv, S., Liu, X., Gu, J., Jiang, Y., Tan, H., & Zhang, Y. (2017). Microstructure analysis of polylactic acid-based composites during degradation in soil. *International Biodeterioration and Biodegradation*, *122*. https://doi.org/10.1016/j.ibiod.2017.04.017

Majamo, S. L., & Amibo, T. A. (2024). Study on extraction and characterization of anchote (Coccinia abyssinica) starch and reinforced enset (Ensete ventricosum) fiber for the production of reinforced bioplastic film. *Heliyon*, *10*(1). https://doi.org/10.1016/j.heliyon.2023.e23098

Marichelvam, M. K., Jawaid, M., & Asim, M. (2019). Corn and rice starch-based bio-plastics as alternative packaging materials. *Fibers*, *7*(4). https://doi.org/10.3390/fib7040032

Marichelvam, M. K., Manimaran, P., Sanjay, M. R., Siengchin, S., Geetha, M., Kandakodeeswaran, K., Boonyasopon, P., & Gorbatyuk, S. (2022). Extraction and development of starch-based bioplastics from Prosopis Juliflora Plant: Eco-friendly and sustainability aspects. *Current Research in Green and Sustainable Chemistry*, *5*. https://doi.org/10.1016/j.crgsc.2022.100296

Melesse GT, Hone FG, Mekonnen MA (2022) Extraction of cellulose from sugarcane bagasse optimization and characterization. Adv Mater Sci Eng 2022. https://doi.org/10.1155/2022/1712207

Naidoo, T. & Rajkaran, A. (2020). Impacts of plastic debris on biota and implications for human health: A South African perspective. *South African Journal of Science*, 116(5-6), 1-8.

Oluwasina, O., Aderibigbe, A., Ikupoluyi, S., Oluwasina, O., & Ewetumo, T. (2024). Physico-electrical properties of starch-based bioplastic enhanced with acid-treated cellulose and graphene oxide fillers. *Sustainable Chemistry for the Environment*, *6*, 100093.

Pathak, V. M. (2017). Review on the current status of polymer degradation: a microbial approach. *Bioresources and Bioprocessing*, *4*(1), 1-31.

Qasim, U., Osman, A. I., Al-Muhtaseb, A. H., Farrell, C., Al-Abri, M., Ali, M., Vo, D. V. N., Jamil, F., & Rooney, D. W. (2021). Renewable cellulosic nanocomposites for food packaging to avoid fossil fuel plastic pollution: a review. In *Environmental Chemistry Letters* (Vol. 19, Issue 1). https://doi.org/10.1007/s10311-020-01090-x

Rajesh, Y., Gautam, N., Saloni, P., Deore, V., Shivde, P., & Dabhade, G. (2024). Agricultural resources in focus: Eco-friendly bioplastic synthesis from corn starch. *Materials Today: Proceedings*. https://doi.org/10.1016/j.matpr.2024.01.025

Raza, M. A., Farwa, U., Danish, M., Ozturk, S., Aagar, A. A., Dege, N., Rehman, S. U., & Al-Sehemi, A. G. (2023). Computational modeling of imines based anti-oxidant and anti-esterases compounds: Synthesis, single crystal and In-vitro assessment. *Computational Biology and Chemistry*, *104*. https://doi.org/10.1016/j.compbiolchem.2023.107880

Razak, S. N. A., Yahaya, N. A., Rohmadi, R. N. A., & Nordin, N. S. (2020). Biodegradable Banana Peels-Based Plastic-A Review. *Multidisciplinary Applied Research and Innovation*, *1*(1).

Şahin, S., & Dege, N. (2021). A newly synthesized small molecule: the evaluation against Alzheimer's Disease by in silico drug design and computational structure analysis methods. *Journal of Molecular Structure*, *1236*. https://doi.org/10.1016/j.molstruc.2021.130337

Sardon, H., & Dove, A. P. (2018). Plastics recycling with a difference. *Science*, *360*(6387). https://doi.org/10.1126/science.aat4997

Silva, R. R. A., Marques, C. S., Arruda, T. R., Teixeira, S. C., & de Oliveira, T. V. (2023). Biodegradation of Polymers: Stages, Measurement, Standards and Prospects. In *Macromol* (Vol. 3, Issue 2). https://doi.org/10.3390/macromol3020023

Sinaga, M. Z. E., Gea, S., Panindia, N., & Sihombing, Y. A. (2018). The preparation of cellulose nanocomposite film from isolated cellulose of corncobs as food packaging. *Oriental Journal of Chemistry*, *34*(1). https://doi.org/10.13005/ojc/340166

Stefani, M., Coudane, J., & Vert, M. (2006). In vitro ageing and degradation of PEG-PLA diblock copolymer-based nanoparticles. *Polymer Degradation and Stability*, *91*(11). https://doi.org/10.1016/j.polymdegradstab.2006.05.009

Sultan, A., Sultan, H., Shahzad, W., Kareem, A., Liaqat, A., Ashraf, Z., ... & Acevedo, R. (2024). Comparative analysis of physical and mechanical properties of starch based bioplastic derived from the pulp and peel of potatoes. *Journal of the Indian Chemical Society*, *101*(10), 101301.

Ungprasoot, P., Muanruksa, P., Tanamool, V., Winterburn, J., & Kaewkannetra, P. (2021). Valorization of aquatic weed and agricultural residues for innovative biopolymer production and their biodegradation. *Polymers*, *13*(17). https://doi.org/10.3390/polym13172838

Wakudkar, H., Mandal, S., Rani, A., Gangil, S., & Das, A. (2025). Experimental investigations on valorization of corncob residues for synthesis of crystalline cellulose. *Biomass Conversion and Biorefinery*, 1-9.

Wicaksono, J. A., Purwadaria, T., Yulandi, A., & Tan, W. A. (2022). Bacterial dynamics during the burial of starch-based bioplastic and oxo-low-density-polyethylene in compost soil. *BMC Microbiology*, *22*(1). https://doi.org/10.1186/s12866-022-02729-1

Zakaria, N. H., Muhammad, N., Sandu, A. v., & Abdullah, M. M. A. B. (2018). Effect of Mixing Temperature on Characteristics of Thermoplastic Potato Starch Film. *IOP Conference Series: Materials Science and Engineering*, *374*(1). https://doi.org/10.1088/1757-899X/374/1/012083