УДК: 502

Vivek P. Bhange, Manju A.Soni, Aeshwarya P.Kopulwar, Vivek M. Nanoti*
LTJSS's Priyadarshini College of Engineering, Nagpur, India
**Corresponding author: V.P. Bhange Email Address: vivekbhange@gmail.com*

NEEM BASED BIOPLASTIC PRODUCTION FROM WASTE BANANA PEELS AND ITS SUSTAINABLE USE FOR GREEN APPLICATION

Due to unfavourable environmental consequences, our society is seeing a replacement for conventional plastics. Thereby, bioplastic is a suitable substitute, as it can be synthesized from different waste supplements and replace with petro based polymer. Due to the non-degradable quality of conventional plastic in nursery plants, their use increases severe environmental issues and general irritation. Hence, substitute potential bioplastic material over traditional plastics is required. Making bioplastic from the Banana peel is an effective solution that reduces the use of non-renewable raw materials. This paper highlights the use of natural substrates (Neem and Banana peel) for bioplastic production and their application in the nursery. The main motive is to produce bioplastic from waste Banana peels, which serve as organic material with abundant availability, cost-efficient, and environment-friendly properties with Neem extract's addition. It is used as a plant support for reducing pollution and evaluating the tensile strength and its degradation.

Key words: *Bioplastic, biodegradability, Neem, Banana peels, Green application, sustainability Introduction*

Вивек П. Бханге, Манджу А. Сони, Эшвария П. Копульвар,*
Вивек М. Наноти, Инженерный колледж Приядаршини LTJSS,
vivekbhange@gmail.com, Нагпур, Индия

ПРОИЗВОДСТВО БИОПЛАСТИКА НА ОСНОВЕ НИМА ИЗ ОТХОДОВ БАНАНОВОЙ КОЖУРЫ И ЕГО УСТОЙЧИВОЕ ИСПОЛЬЗОВАНИЕ В ЭКОЛОГИЧЕСКИ ЧИСТЫХ ЦЕЛЯХ

Из-за неблагоприятных экологических последствий наше общество ищет замену обычным пластикам. Биопластик является подходящей заменой, так как его можно синтезировать из различных добавок отходов и заменить полимером на основе нефти. Из-за того, что обычный пластик в саженцах не разлагается, его использование усугубляет серьезные экологические проблемы и вызывает общее раздражение. Следовательно, требуется замена потенциального биопластика традиционным пластиком. Изготовление биопластика из банановой кожуры — эффективное решение, позволяющее сократить использование невозобновляемого сырья. В этой статье рассказывается об использовании натуральных субстратов (нима и банановой кожуры) для производства биопластика и их применении в питомниках. Основным мотивом является производство биопластика из отходов банановой кожуры, которые служат органическим материалом с высокой доступностью, экономичностью и экологически чистыми свойствами с добавлением экстракта нима. Он используется в качестве поддержки растений для уменьшения загрязнения и оценки прочности на растяжение и ее деградации.

Ключевые слова: *биопластик, биоразлагаемость, ним, банановая кожура, зеленое применение, устойчивость.*

Вивек П.Бханге, Манжу А.Сони, Аэшвария П.Копулвар,*
Вивек М. Наноти, LTJSSтин Приардаршини инженердик
колледжи, vivekbhange@gmail.com, Нагпур, Индия

БАНАН КАБЫГЫНЫН КАЛДЫКТАРЫНАН БИОПЛАСТИКА ӨНДҮРҮҮ ЖАНА АНЫ ЖАШЫЛ КОЛДОНУУ ҮЧҮН ТУРУКТУУ ПАЙДАЛАНУУ

Экологиялык жагымсыз кесепеттерден улам биздин коом кадимки пластмассаларды алмаштырууну туура көрүп жатат. Биопластик ылайыктуу алмаштыруучу болуп саналат, анткени аны ар кандай калдык кошулмалардан синтездеп, петро негизиндеги полимер менен алмаштырууга болот. Питомниктерде кадимки пластмасса бузулбай тургандыктан, аларды колдонуу курч экологиялык көйгөйлөрдү жана жалпы кыжырдануунуу күчөтөт. Демек, салттуу пластмассага караганда потенциалдуу биопластикалык материалды алмаштыруу талап кылынат. Банандын кабыгынан биопластика жасоо кайра жаралбаган чийки заттарды колдонууну азайткан эффективдүү чечим болуп саналат. Бул кагаз биопластика өндүрүү үчүн табигый субстраттарды (Ним жана Банан кабыгын) колдонууну жана аларды питомниктерде колдонууну баса белгилейт. Негизги мотив – банандын кабыгынын калдыктарынан биопластика өндүрүү, ал органикалык материал катары кызмат кылат, ал Неем экстрактынын кошулмасы менен көп жеткиликтүү, экономикалык жактан үнөмдүү жана айлана-чөйрөгө зыянсыз. Бул булгануунуу азайтуу жана чыңалуу күчүн жана анын бузулушун баалоо үчүн өсүмдүктүк колдоо катары колдонулат.

Өзөктүү сөздөр: *биопластикалык, биодеградация, Ним, Банан кабыгы, Жашыл колдонуу, туруктуулук.*

Plastic consumption is more than that of the world average in developing countries due to the higher urbanization and economic development [1]. In our regular life, plastic materials are the most broadly used polymer. Over 140 million tons of petroleum-based polymers are generated each year from raw materials, crude oil, coal, and natural gas and applied to plastics and their derivatives [2]. CO_2 and many other toxic compounds are emitted in plastic degradation [3]. It is approximated that about 2.8 kg of CO_2 is evolved on burning 1 kg of plastic [4]. The excess produced plastic is deposited as a landfill. It is degraded slowly, causing the original products to remain in landfills for hundreds or even thousands of years and unfavorably affect waterways, lands, and oceans [5, 6].

Due to the environmental problems of non-biodegradable plastic, the evolution of bio- plastic arises. Bioplastic origin is cellulose, starch, sugar, etc., which are primarily renewable [7]. Starch is the typical source of bioplastic production, and starch-based plastics are served a promising raw material for manufacturing plastic and safe for the environment [8]. A good point of supply for starch and organic material is that banana peels serve as large availability, cost efficiency, and environment-friendly properties. Reducing the use of non-renewable raw materials makes bioplastic from the Banana peel an effective solution. Some studies have been investigated for the production of bioplastic film using Banana peels. Ghamande et al. (2018**)** formed bioplastic from Banana peels using meta-bisulphate to prevent microorganisms and glycerol for increasing flexibility [9]. Noor et al. (2017) studied bioplastic film formation with two starch sources, corn starch and Banana peel starch, with different corn concentrations [10]. Jayachandra et al. (2016) reported using fruit waste, mainly Banana peel, for bioplastic production, as a potential alternative source for conventional plastics [11].

Currently, due to the non-degradable nature of conventional plastic in nursery plants, their use raises severe environmental issues so that bioplastic will be a trendy, ecological, and user-friendly alternative to this. It will be beneficial for the surroundings if the resulting bioplastic degrades back into CO_2 and water. Degradation happens when the soil microbial consortia begin consuming bioplastics, and the final release of monomers to the environment has less hazardous impacts on the landscape. Thus, to create a sustainable situation and limit plastic waste disposal in the environment, bioplastics generation earned a lot of recognition due to biodegradability [12].

However, this study presents some adequate viable methodologies for investigating the product's quality produced using the bioplastics materials. The materials synthesized usingBanana peels have the properties of flexibility, user-friendliness, and degradation tractable. The main motive is to produce bioplastic made from Banana peels with Neem extract's addition and use it as a plant support for reducing pollution. Materials and methods

1.1 Materials

Banana peels, Neem leaves, Glycerol, HCl, NaOH, $Na_2S_2O_5$ and Distilled water were used in this study.

1.2 Preparation of Banana Peel Paste

Waste Banana samples (*Musa acuminata*) were collected from the local market of Nagpur city, India. Afterward, the Banana peel was removed and washed to ensure proper cleaning. The cleaned skin was sliced with scissors in small pieces and dip in (0.2M) sodium metabisulphite solution for 40 minutes, which acts as an antioxidant and preservative, increasing the biodegradation period of plastic. Banana peels are boiled in distilled water, and the peels are now left to dry on filter paper; after drying, a uniform paste is formed.

1.3 Production of Neem based bioplastics

Neem leaves were collected and washed properly to remove dust. The extract is contained in a beaker after crushing the Neem leaves and then filtered using filter paper. The purified extract is boiled to increase concentration. This Neem Extract is added in 100 g of Banana paste with 0.5 N HCl and stirred properly. The mixture is kept some time to provide sufficient residence time by adding Glycerol as a Plasticizer. NaOH was used to adjust the desired pH, i.e., neutral. The mixture was cast onto a flat platform and dried at temperature 600C for 6 hours. Once set, bioplastic film was cooled to ambient temperature and is stored in dry conditions.

1.4 Testing methods 2.4.1Tensile Strength

For testing the tensile strength of the bioplastic, specimens were placed in the grips of a Universal Test Machine at a specified grip separation and pulled until failure. Tensile strength (MPa) was displayed from the tensile test. Five specimens were measured for sample tensile strengths and represented the average result of these.

1.4.2 Biodegradability test

Soil burial degradation test was conducted for determination of the biodegradable behaviour of bioplastics. The test was performed by using the samples of bioplastic film. The time interval of 45 days was considered, and the film was observed accordingly. Degradation testing serves to determine the extent of damage to bioplastics.

1.4.3 Microbial testing

For biofilm microbial testing, the nutrient media is prepared by the addition of nutrient agar into the distilled water. To remove present contaminants, the solution is sterile and then poured into petri plates and kept undisturbed until the media is solidified. The bacterial culture is inoculated, and the pieces of bioplastics are kept on the nutrient media. The petri plates are kept in the incubators for the microbial growth.

1.5 Application of Neem based bioplastic in nursery

Neem based bioplastic produced has applied in the nursery for plant samples. The plant is being wrapped by the polymeric film such that it is biodegradable so it can be buried directly into the soil. Thus, environmental pollution can be reduced. The growth of plants in the plant support made of bioplastic with the time interval required for the proper growth is studied.

2. Results and discussion

The Neem based bioplastic produced from Banana peels has the natural colour as yellowish, and it is in the form of a thin sheet. Tensile strength is the highest pull that can be achieved until the film can bear before breaking up [13]. The tensile strength of prepared Neem based bioplastic material was found to be 9.13 MPa.

For the biodegradable test of bioplastic, the results showed that continuous biodegradation is taking place at certain time intervals, which gives the assurance that the Neem based bioplastic film produced is 100% biodegradable. Figure 1 shows the process of biodegradation of bioplastic. It shows the biodegradation effect on the piece of bioplastic from the initial stage to an interval of 45 days. It is observed that the strength and thickness of the bioplastic decrease as it is exposed to biodegradation. Biodegradation is dependent on various factors like exposed surface area, the microbial activity of the environment, temperature, moisture, pH, and molecular weight of the bioplastics [14]. Because of the higher microbial biodiversity soil environment contained a high number of bioplastic-degrading microorganisms than in other situations such as marine waters. It was reported that the fungal species in soil or compost had a more tendency to degrade starch-based bioplastics [15]. Once this bioplastic film is buried into the soil, it will be transformed into carbon dioxide and water.

The test for microbial testing showed that there is not much growth of fungus in the petri plates containing bioplastic since the Neem-based bioplastic has the pesticidal properties and the petriplates used as a sample which does not contain any bioplastic in it exhibits the growth of fungus.

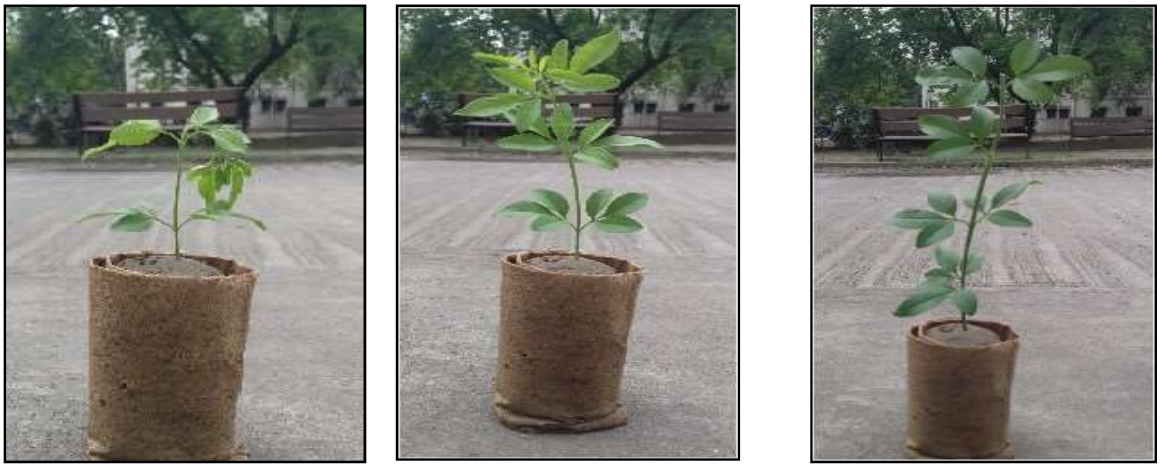
Initial stage
After 15 days

After 30 days

Completely degraded after 45 days

Figure 1: Different stages showing biodegradation of bioplastic film.

2.1 Application of Neem based bioplastic in Nursery



Final Initial Intermediate

Figure 2: Neem based polymeric film for plantlet support.

Figure 2 shows the plant's growth in the plant support made of bioplastic with the time interval required for the proper development. The Neem-based polymeric film produced has pesticide properties. Plantlet support is completed by letting the plant be wrapped with bioplastic and buried directly into the soil. Neem also has pesticide properties; therefore, the plant gets the fertilizer directly, and there is no necessity for external fertilizer. Bioplastic is used to prevent environmental pollution, as it is easily biodegradable and can be transformed into simpler molecules. The bioplastic does not get accumulated in nature. Conventional plastics are petroleum-based plastics and require a high amount of energy for production. The Neem-based bioplastic is the bioplastic, which partially restricts the attack of small pests. The Neem has natural pesticidal features and prevents bioplastic from pests. Pests can damage the integrity of the bioplastic and thus results in a weak sheet of bioplastic. To prevent the damage pesticide property of Neem is helpful. They can be made in various colors and have an esthetic look for the consumers to buy. They certainly would not cause any pollution as their composition is entirely from biomasses and does not contain toxins.

3. Conclusions

The Neem based polymeric film produced has pesticidal properties, and the application of plantlet support can be made successfully by letting plant to be wrapped with bioplastic and can be buried directly into the soil. The product is helpful for environmental protection. It will help reduce plastic pollution and is the best possible alternative for traditional oil and petroleum- based plastic. The bioplastic obtained from the Banana peel with the additional Neem as a substrate is useful as plant support. The tensile strength gained is of 9.13 MPa. However, the prepared bioplastic has satisfactory degradation properties, and tensile properties can make it feasible for its utilization at commercial scale.

Conflict of interest: On behalf of all authors, the corresponding author states that there is no conflict of interest.

References:

1. Muenme S, Chiemchaisri W (2016) Enhancement of biodegradation of plastic wastes via methane oxidation in semi-aerobic landfill. Int. Biodeterior. Biodegr. 113:244–255.

2. Barry E. DiGregorio (2009) Biobased Performance Bioplastic: Mirel, Chemistry & Biology, 16: 1-2.

3. Emadian SM, Onay TT, Demirel B (2017) Biodegradation of bioplastics in natural U environments, Waste Manag. 59:526–536.

4. Burgos N, Valdés A, Jiménez A (2016) Valorization of agricultural wastes for the production of protein-based biopolymers, J. Renew. Mater. 4:165–177.

5. Raaz Maheshwari, Bina Rani, Sangeeta, Parihar and Anju Sharma (2013) Eco-friendly Bioplastic for Uncontaminated Environment. Research Journal of Chemical and Environmental Sciences 1: 44-49.

6. Lytle, Claire Le Guern (2015) "Plastic Pollution"Coastal Care.

7. Meeks D, Hottle T, Bilec MM, Landis AE (2015) Compostable biopolymer use in the real world: Stakeholder interviews to better understand the motivations and realities of use and disposal in the US, Resour. Conserv. Recycl. 105:134–142.

8. Sofiah, Yuniar, Martha Aznury, Melianti (2019) Mechanical Properties of Bioplastics Product from Musa Paradisica Formaty pica Concentrate with Plasticizer Variables, Journal of Physics: Conference Series 1167: 1-7.

9. Ghamande M, Kulkarni A, Shah N, Kothari S, Bhosale S (2018) Bioplastic (generating plastic from Banana peels). International conference on new frontiers of engineering, management, social science and humanities, 39-42.

10. Noor Fatimah Kader Sultan, Wan Lufti Wan Johari (2017) The development of Banana Peel/Corn Starch Bioplastic Film: A Preliminary Study, Bioremediation Science and Technology Research , 5:12-17.

11. Jayachandra Yaradoddi, Vinay Patil, Sharanabasava Ganachari, Nagaraj Banapurmath, Anand Hunashyal, Ashok Shettar (2016) Biodegradable Plastic Production From Fruit Waste Material And Its Sustainable Use For Green Applications, International Journal of Pharmaceutical Research & Allied Sciences, 5(4): 56-66.

12. Mehdi Emadian, Turgut T. Onay, Burak Demirel (2017) Biodegradation of bioplastics in natural environments. Waste Management 59:526–536.

13. Krochta JM, Mulder Johnston (1997) Edible and Biodegredable Polymer Film: Challanges and Oppurtunities. J.Food tech. 5(2): 61-74.

14. Boopathy R. (2000) Factor limiting bioremediation technologies. Bioresource. Technol. 74: 63-67.

15. Accinelli C, Saccà ML, Mencarelli M, Vicari A, (2012) Deterioration of bioplastic carrier bags in the environment and assessment of a new recycling alternative. Chemosphere 89: 136–143.