

Training on the Synthesis of Cassava Starch-Based Bioplastics (*Manihot esculenta*) Using the Gelatinization Method

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Abstrak

Sampah plastik menjadi salah satu permasalahan lingkungan utama di wilayah Gresik karena sifatnya yang sulit terurai dan memberikan dampak negatif bagi lingkungan. Oleh karena itu, dilakukan kegiatan pelatihan pembuatan bioplastik untuk meningkatkan kesadaran dan pengetahuan siswa mengenai alternatif plastik ramah lingkungan. Kegiatan pengabdian kepada masyarakat ini dilaksanakan di Laboratorium Teknik Kimia Universitas Muhammadiyah Gresik dengan melibatkan siswa SMA Muhammadiyah 10 GKB sebagai peserta. Metode kegiatan meliputi tahap observasi, persiapan, dan pelaksanaan. Pelaksanaan kegiatan dilakukan melalui pemaparan materi, demonstrasi langsung, serta praktik pembuatan bioplastik berbahan dasar pati singkong. Bioplastik dibuat menggunakan 25g pati singkong, 250mL aquadest, 8mL asam asetat, dan 8,75mL gliserin yang dipanaskan pada suhu 80°C selama 20 menit kemudian dicetak. Untuk mengetahui efektivitas kegiatan, dilakukan *pre-test* dan *post-test* kepada peserta. Hasil kegiatan menunjukkan adanya peningkatan nilai rata-rata peserta dari 78,6 pada *pre-test* menjadi 94,1 pada *post-test*, yang menandakan peningkatan pemahaman peserta secara signifikan. Selain itu, seluruh peserta berhasil menghasilkan produk bioplastik tanpa adanya kegagalan selama proses praktik. Hasil tersebut menunjukkan bahwa kegiatan pelatihan efektif dalam meningkatkan pengetahuan dan keterampilan siswa mengenai pembuatan bioplastik yang ramah lingkungan.

Kata kunci— Asam Asetat, Bioplastik, Gliserin, Pati Singkong

Abstract

Plastic waste has become one of the major environmental problems in the Gresik area due to its non-biodegradable nature and its negative impact on the environment. Therefore, an educational activity on bioplastic production was conducted to increase students' awareness and knowledge regarding environmentally friendly alternatives to conventional plastics. This community service activity was carried out at the Chemical Engineering Laboratory of Universitas Muhammadiyah Gresik and involved students from SMA Muhammadiyah 10 GKB as participants. The activity methods consisted of observation, preparation, and implementation stages. The implementation included material

presentation, direct demonstration, and hands-on practice in producing bioplastics from cassava starch. The bioplastic was prepared using 25g of cassava starch, 250mL of distilled water, 8mL of acetic acid, and 8.75mL of glycerin, followed by heating at 80°C for 20 minutes and molding. To evaluate the effectiveness of the activity, pre-tests and post-tests were conducted. The results showed an increase in the average participant score from 78.6 in the pre-test to 94.1 in the post-test, indicating a significant improvement in participants' understanding. In addition, all participants successfully produced bioplastic products without any failure during the practical session. These results demonstrate that the training activity was effective in improving students' knowledge and practical skills related to environmentally friendly bioplastic production.

Keywords— Acetic Acid, Bioplastics, Cassava Starch, Glycerin

1. INTRODUCTION

The issue of conventional plastic waste has become an increasingly urgent environmental concern, particularly in urban and industrial areas such as Gresik Regency. The extensive use of single-use plastics in daily activities, including within student communities, contributes significantly to the growing volume of non-biodegradable waste [1]. Petroleum-based plastics require an extremely long time to decompose, resulting in continuous environmental pollution [2]. Therefore, educational and innovative efforts are needed to introduce more environmentally friendly material alternatives to society, especially to the younger generation [3].

One promising alternative is cassava starch-based bioplastic. Cassava is an abundant agricultural commodity in Indonesia and can be obtained easily at a relatively low cost [4]. The high starch content of cassava enables it to be utilized as the primary matrix in the production of biodegradable bioplastics [5]. In addition to being environmentally friendly, the use of cassava as a raw material for bioplastic production can increase the added value of local commodities while also serving as a contextual learning medium for students [6].

However, knowledge and practical skills related to the production of cassava-based bioplastic are still limited, particularly among high school students. Limited laboratory facilities and insufficient access to experiment-based learning have become obstacles in introducing this technology effectively. Therefore, activities that bridge theoretical understanding and practical application are highly necessary. As an effort to address these challenges, a community service program in the form of bioplastic production

training from cassava was conducted involving students of SMA Muhammadiyah 10 GKB as participants.

The training was carried out at the Chemical Engineering Laboratory of Universitas Muhammadiyah Gresik (UMG), allowing participants to gain direct experience in the scientific and practical processes of bioplastic production. The training activities included cassava starch processing, mixing with plasticizers such as glycerol, heating (gelatinization), as well as molding and drying of the bioplastic products [7], [8].

This training aimed to enhance students' understanding of plastic pollution issues while equipping them with practical skills in producing environmentally friendly products [9]. Furthermore, the activity was expected to foster creativity, innovation, and awareness regarding the importance of sustainable utilization of local resources. In this way, students are expected not only to become recipients of knowledge, but also potential agents of change in reducing the use of conventional plastics within their surroundings.

Therefore, the implementation of cassava-based bioplastic production training for students of SMA Muhammadiyah 10 GKB at the Chemical Engineering Laboratory of UMG represents a strategic step in integrating education, technology, and environmental awareness. This activity is expected to provide a meaningful contribution to improving environmental literacy and practical skills among the younger generation in Gresik Regency.

2. METHOD

Observation

The observation stage began with an analysis

of environmental issues in the Gresik area, particularly the increasing amount of plastic waste that is difficult to decompose and its impact on the environment. This stage was followed by coordination with the relevant parties regarding the implementation of the activity.

Activity Preparation

The preparation stage began with coordination between the university students as the organizing committee and the management of SMA Muhammadiyah 10 GKB to determine the schedule of activities. Furthermore, the materials and equipment needed for the bioplastic production process were prepared. At this stage, pre-test and post-test questions were also designed to evaluate the effectiveness of the activity and measure the participants' understanding before and after the program. The questions are presented in Table 1.

Table 1 List of Pre-Test and Post-Test Questions for Students of SMA Muhammadiyah 10 GKB, 2026

No.	Questions
1.	What is bioplastic?
2.	Which of the following is NOT one of the materials used in the production of bioplastics?
3.	Which of the following is one of the primary raw materials used in bioplastic production?
4.	What will happen to the tensile strength of a bioplastic if the glycerol content is too high?
5.	Why do starch-based bioplastics have disadvantages when used over a long period of time?
6.	Which instrument is commonly used to analyze the structure of bioplastics?
7.	What is the major environmental problem caused by conventional plastics?
8.	What is one of the main objectives of producing bioplastics?
9.	How does the hygroscopic nature of bioplastics affect their properties?
10.	A researcher aims to develop a bioplastic with high strength and adequate flexibility. Based on research findings, which strategy would be most appropriate to achieve this objective?

Implementation of Activities

The activities were conducted at the Chemical Engineering Laboratory of Universitas Muhammadiyah Gresik and attended by students of SMA Muhammadiyah 10 GKB. The

implementation began with a pre-test session to assess the participants' initial understanding of bioplastics and environmental issues related to plastic waste. This was followed by a direct demonstration of the bioplastic production process, in which the students actively participated by following each step of the preparation method. The activity also included an explanation of the materials and equipment used, accompanied by a question-and-answer session to enhance participants' understanding. At the end of the activity, a post-test was conducted to evaluate the effectiveness of the program and measure the improvement in participants' knowledge after the training session.



Figure 1 Direct Demonstration of the Bioplastics Production at the Chemical Engineering Laboratory of Universitas Muhammadiyah Gresik, 2026

Sintesis Bioplastics Method

Preparation of Cassava Starch

- Peel the cassava and wash it thoroughly with clean water to remove dirt and impurities
- Cut the cassava into small pieces to facilitate the grinding process
- Blend or grind the cassava with an adequate amount of water until a smooth slurry is formed
- Filter the slurry using a clean cloth or filter to separate the liquid extract from the solid residue
- Allow the filtrate to stand for several hours until the starch precipitates at the bottom of the container
- Remove the supernatant carefully and collect the starch sediment

- g. Dry the obtained cassava starch until a dry starch powder is formed

Preparation of Bioplastic

- a. Weigh 25 g of cassava starch and mix it with 250 mL of distilled water (aquadest)
- b. Add 8 mL of acetic acid and 8.75 mL of glycerin into the mixture
- c. Stir the mixture until all components are evenly mixed
- d. Heat the mixture at 80°C for 20 minutes while continuously stirring until a homogeneous gel is formed
- e. Pour the bioplastic solution into a mold or casting tray
- f. Allow the bioplastic to cool and dry until a solid bioplastic film is obtained



Figure 2 Production of Bioplastics at the Chemical Engineering Laboratory of Universitas Muhammadiyah Gresik, 2026

3. RESULT AND DISCUSSION

The implementation of the bioplastic training activity showed a positive impact on the participants’ understanding of environmentally friendly plastic alternatives and the process of bioplastic production from cassava starch. To

evaluate the effectiveness of the activity, pre-tests and post-tests were conducted for all participating students of SMA Muhammadiyah 10 GKB.

The pre-test results indicated that the participants’ initial understanding of bioplastics and plastic waste management was still relatively moderate, with an average score of 78.6. After the delivery of the material, direct demonstrations, and hands-on practice in producing bioplastics, the participants showed a significant improvement in their comprehension. The post-test results demonstrated an increase in the average score to 94.1. The test result are presented in Table 2.

Table 2 Test Result of Pre-Test and Post-Test Questions for Students of SMA Muhammadiyah 10 GKB, 2026

Participants	Pre-Test Score	Post-Test Score
1	80	100
2	80	90
3	80	100
4	60	100
5	90	100
6	90	90
7	70	80
8	70	100
9	60	90
10	90	100
11	80	100
12	100	100
13	90	100
14	80	100
15	100	100
16	80	100
17	80	100
18	70	80
19	70	80
20	90	100
21	50	80
22	70	80

In addition to the improvement in test scores, all students successfully produced bioplastic products during the practical session, and no failures were observed in the bioplastic fabrication process. The resulting bioplastics were successfully formed according to the expected procedure, indicating that the participants were able to properly follow the preparation steps and understand the production

method.

The improvement in the average score from 78.6 to 94.1 indicates that the activity was effective in enhancing the participants' knowledge and practical understanding of bioplastic production. The direct practical method used during the training allowed students to actively participate in every stage of the process, making the learning experience more interactive and easier to understand. In addition, the combination of theoretical explanations, demonstrations, and question-and-answer sessions helped participants better comprehend the environmental issues related to plastic waste and the potential use of biodegradable materials such as cassava starch. These findings are consistent with a study by Nugrahadi et al., which provided education on waste bank innovations in Kediri City and showed that respondents' knowledge increased to 74.17, up from 56.67 before the education was provided [10].



Figure 3 Production of Bioplastics at the Chemical Engineering Laboratory of Universitas Muhammadiyah Gresik, 2026

4. CONCLUSION

The bioplastic training activity conducted at the Chemical Engineering Laboratory of Universitas Muhammadiyah Gresik successfully improved the knowledge and practical skills of SMA Muhammadiyah 10 GKB students regarding environmentally friendly plastic alternatives. The activity provided participants with both theoretical understanding and direct experience in producing bioplastics from cassava starch.

The effectiveness of the program was demonstrated by the increase in the average test

score from 78 in the pre-test to 94 in the post-test. In addition, all participants successfully produced bioplastic products without any failures during the practical session. These results indicate that the training method involving presentations, demonstrations, and hands-on practice was effective in enhancing students' understanding and participation.

Overall, this community service activity contributed positively to increasing environmental awareness among students, particularly regarding the utilization of biodegradable materials as an alternative solution to plastic waste problems.

5. SUGGESTION

To maximize the impact of this community service program, similar bioplastic training activities should be conducted on a regular basis and expanded to involve a larger number of participants from different educational institutions. Such efforts can help broaden environmental awareness and promote the adoption of sustainable alternatives to conventional plastics among students and the wider community.

Furthermore, future programs are recommended to include additional topics related to bioplastic characterization, such as mechanical strength, water resistance, and biodegradability testing. Participants could also be introduced to variations in raw materials, plasticizer concentrations, and processing conditions to better understand their effects on bioplastic properties. These improvements are expected to enhance participants' knowledge, encourage innovation, and support the development of environmentally friendly products based on local resources.

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