

## Enhancing renewable energy literacy through aromatic biobriquettes production training at Al-Amalul Khair Islamic Boarding School

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### Abstract

Limited renewable energy literacy and inadequate utilization of organic waste remain significant challenges in school-based environmental education. This community service program aimed to enhance renewable energy literacy and practical biomass utilization skills among students and teachers at Al-Amalul Khair Islamic Boarding School, Palembang, Indonesia, through aromatic biobriquette production training. The program employed a community-based learning approach consisting of lectures, technical demonstrations, hands-on practice, and interactive discussions. Thirty participants were involved in the activity. Program effectiveness was evaluated using a one-group pretest–posttest design. The results showed a significant increase in participants' knowledge, with the mean score improving from 45.67 before the training to 95.00 after the training. In addition, participants demonstrated strong engagement during practical activities and expressed willingness to apply aromatic biobriquette technology for sustainable organic waste management. The findings indicate that hands-on training effectively improves renewable energy literacy and technical competencies related to biomass-based energy production.

Keywords: Aromatic Biobriquette, Renewable Energy Literacy, Biomass Energy, Coffee Grounds

### Abstrak

Literasi energi terbarukan yang terbatas dan pemanfaatan limbah organik yang tidak memadai masih menjadi tantangan signifikan dalam pendidikan lingkungan sekolah. Program pengabdian masyarakat ini bertujuan untuk meningkatkan literasi energi terbarukan dan keterampilan pemanfaatan biomassa praktis di kalangan siswa dan guru di Pondok Pesantren Al-Amalul Khair, Palembang, Indonesia, melalui pelatihan produksi biobriket aromatik. Program ini menggunakan pendekatan pembelajaran berbasis masyarakat yang terdiri dari ceramah, demonstrasi teknis, praktik langsung, dan diskusi interaktif. Tiga puluh peserta terlibat dalam kegiatan ini. Efektivitas program dievaluasi menggunakan desain tes awal dan tes akhir satu kelompok. Hasil menunjukkan peningkatan yang signifikan dalam pengetahuan peserta, dengan skor rata-rata meningkat dari 45,67 sebelum pelatihan menjadi 95,00 setelah pelatihan. Selain itu, peserta menunjukkan keterlibatan yang kuat selama kegiatan praktis dan menyatakan keinginan untuk menerapkan teknologi biobriket aromatik untuk pengelolaan limbah organik berkelanjutan. Temuan menunjukkan bahwa pelatihan praktik langsung secara efektif meningkatkan literasi energi terbarukan dan kompetensi teknis terkait produksi energi berbasis biomassa.

Kata kunci: Biobriket Aromatik, Literasi Energi Terbarukan, Energi Biomassa, Ampas Kopi

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## 1. Introduction

The growing accumulation of organic waste, together with the increasing for sustainable energy solutions, has become a pressing environmental challenge worldwide (Ansari et al., 2024; Hasan et al., 2023). Although organic wastes such as coffee grounds, sawdust, dry leaves, and fruit peels can serve as valuable renewable energy feedstocks, they are still frequently discarded or disposed of through open burning practices (Adeleke et al., 2023; Umar et al., 2025). Improper disposal practices may contribute to environmental pollution, greenhouse gas emissions, and inefficient resource utilization. Consequently, there is a growing need for innovative approaches that integrate waste valorization and renewable energy production within educational and community contexts (Adetunji et al., 2023). Preliminary observations conducted at Al-Amalul Khair Islamic Boarding School, Palembang, revealed that organic waste generated within the surrounding environment was not optimally utilized. Most organic residues were disposed of as waste or burned, while opportunities for converting these materials into value-added energy products remained largely unexplored. At the same time, environmental and renewable energy topics were primarily delivered through theoretical instruction, providing limited opportunities for students to engage in practical and experiential learning activities.

Integrating hands-on activities into renewable energy education is crucial for enhancing environmental literacy and deepening students' understanding of sustainability principles (Fatmawati et al., 2026; Pambudi et al., 2024). Previous studies have demonstrated that practical learning approaches can significantly enhance student engagement, knowledge retention, and problem-solving skills in environmental education. However, many renewable energy education programs continue to prioritize theoretical awareness and traditional biomass utilization, with relatively little emphasis on experiential learning, practical production capabilities, and innovation in biomass-derived products (López et al., 2026).

Among the emerging approaches, the development of aromatic biobriquettes has gained attention as a sustainable technology that converts biomass waste into renewable solid fuels while incorporating natural aromatic additives to enhance their value and acceptability (Roman & Grzegorzewska, 2024). Besides functioning as a sustainable alternative energy source, aromatic biobriquettes offer enhanced value by increasing user acceptability and alleviating the unpleasant odors commonly associated with biomass combustion (Wulandari et al., 2024). In addition to serving as an alternative energy source, aromatic biobriquettes provide added value through improved user acceptance and reduced unpleasant combustion odors. The production process provides an accessible and hands-on learning platform through which students can explore concepts related to renewable energy, waste management, and green technology (Cocu et al., 2025).

Although several community-based programs have introduced biomass briquette production, few studies have focused on aromatic biobriquettes as an educational medium for renewable energy literacy. Furthermore, limited attention has been given

to integrating hands-on training activities with international academic collaboration to enhance learning outcomes and community engagement.

Therefore, this program aimed to enhance renewable energy literacy and biomass utilization skills among students and teachers at Al-Amalul Khair Islamic Boarding School through aromatic biobriquette production training. The novelty of this activity lies in the integration of aromatic biobriquette technology, community-based experiential learning, and international collaboration with Politeknik Merlimau Melaka, Malaysia. The program is expected to promote sustainable organic waste management, strengthen environmental awareness, and improve practical competencies related to renewable energy applications within educational institutions.

## 2. Method

This community service program was conducted at Al-Amalul Khair Islamic Boarding School, Palembang, South Sumatra, Indonesia. The activity involved 30 students and teachers who voluntarily participated in aromatic biobriquette production training. The program adopted a community-based learning approach using a one-group pretest–posttest quasi-experimental design to evaluate participants' knowledge improvement following the educational intervention.

The intervention consisted of four sequential phases: (1) preparation and needs assessment, (2) training implementation, (3) hands-on aromatic biobriquette production, and (4) evaluation and reflection. During the preparation phase, preliminary observations and discussions were conducted with school administrators to identify existing environmental issues, educational needs, and logistical requirements. Training materials, instructional media, and practical equipment were subsequently prepared.

The training phase included lectures, interactive discussions, video-assisted demonstrations, and workshops on renewable energy concepts, biomass utilization, and aromatic biobriquette production techniques. Participants were then engaged in hands-on activities involving the preparation and molding of aromatic biobriquettes using locally available organic waste materials and natural aromatic additives.

Program effectiveness was evaluated using a structured questionnaire administered before and after the intervention. The questionnaire consisted of ten multiple-choice questions assessing participants' understanding of renewable energy principles, biomass utilization, and aromatic biobriquette production procedures. Content validity of the instrument was reviewed by experts in renewable energy and educational assessment. Instrument reliability was examined through internal consistency testing using Cronbach's alpha prior to implementation (Taber, 2018). Pretest and posttest scores were analyzed using a paired sample t-test to determine whether statistically significant differences existed following the training. The significance level was established at  $p < 0.05$ .

Indicators of program success included: (1) improvements in participants' knowledge scores as evidenced by pretest–posttest comparisons, (2) active

participation and engagement during workshops and practical sessions, and (3) participants' expressed intention to adopt and disseminate aromatic biobriquette production practices within their school and household environments. Although long-term behavioral change was not assessed due to time limitations, future studies are recommended to incorporate follow-up evaluations to examine the sustainability of knowledge application and environmental practices after program completion. The implementation of this program is illustrated in Figure 1 and 2 below.



Figure 1. Documentation of the Community Service Activities



Figure 2. Door Prize Distribution and Closing Question-and-Answer Session at the End of the Community Service Program

### 3. Results

The training program demonstrated positive outcomes in improving participants' understanding of renewable energy concepts and aromatic biobriquette production. Quantitative evaluation using pretest and posttest questionnaires indicated a substantial increase in participants' knowledge following the intervention (Muthmainnah et al., 2025). In addition to the improvement in knowledge, participants exhibited high levels of enthusiasm and active involvement throughout the activity. As shown in Figure 3, teachers and students actively participated in the socialization

session by engaging in discussions, asking questions, and responding to the materials presented by the facilitators. This positive interaction suggests that the combination of lectures, demonstrations, and hands-on learning effectively enhanced participants' interest and understanding of biomass utilization as a renewable energy source (Kotsis, 2024).



Figure 3. Community Based-Training Session on Aromatic Biobriquette Production

Table 1 presents a summary of the descriptive statistics and inferential analysis of participants' knowledge scores. The average pretest score was 45.67, indicating limited prior understanding of renewable energy concepts and biomass utilization. Following the training, the average posttest score increased to 95.00, representing an average improvement of 49.33 points. Although most participants experienced considerable gains, variations in score improvements were observed, reflecting differences in participants' initial knowledge levels, learning experiences, and engagement during the activities.

Table 1. Summary of Participants' Knowledge Scores Before and After the Training

Variable	Mean ± SD
Pretest Score	45.67 ± 7.90
Posttest Score	95.00 ± 6.72
Mean Difference	49.33 ± 7.54
Paired t-test	p < 0.001

The paired sample t-test revealed a statistically significant difference between pretest and posttest scores ( $p < 0.001$ ), indicating that the training effectively enhanced participants' knowledge regarding renewable energy and aromatic biobriquette production. These findings suggest that the combination of lectures, demonstrations, and hands-on practice provided meaningful learning experiences that facilitated knowledge acquisition (van Eijck et al., 2025).

In addition to quantitative improvements, participants demonstrated high levels of engagement throughout the practical sessions. They actively participated in discussions, raised questions concerning biomass utilization and briquette production techniques, and expressed interest in independently applying the acquired skills. Such responses support experiential learning theory, which emphasizes that active

involvement and direct experience enhance learning outcomes and increase learner motivation (U-senyang, 2024). Similar findings have been reported in previous studies, indicating that practical environmental education contributes positively to environmental awareness, technical competence, and sustainable behavior.

Despite these encouraging findings, this study has several limitations. The evaluation focused primarily on short-term changes in knowledge immediately after the intervention and did not assess long-term behavioral changes or the sustained application of aromatic biobriquette production practices. Future community engagement programs are therefore encouraged to incorporate follow-up assessments to examine the extent to which participants adopt and disseminate renewable energy practices within their households and communities.

Overall, the findings indicate that community-based training on aromatic biobriquette production can serve as an effective strategy for improving renewable energy literacy, promoting sustainable organic waste management, and strengthening practical competencies among students in educational settings (Heriyanti et al., 2025).

#### **4. Conclusion**

The community service program on aromatic biobriquette production conducted at Al-Amalul Khair Islamic Boarding School successfully enhanced participants' knowledge and understanding of renewable energy utilization through biomass waste valorization. The training provided teachers and students with practical insights into converting organic waste into economically valuable aromatic biobriquettes, thereby promoting awareness of the environmental, economic, and social benefits of sustainable biomass utilization.

The evaluation results demonstrated a significant improvement in participants' knowledge following the intervention, as indicated by the increase in the average score from 45.67 in the pretest to 95.00 in the posttest. These findings suggest that the combination of lectures, interactive discussions, demonstrations, and hands-on practice effectively strengthened renewable energy literacy and technical competencies related to aromatic biobriquette production.

In addition, participants showed high levels of enthusiasm and active engagement throughout the training activities, as reflected in their participation during discussions and practical sessions. The positive response indicates that experiential learning approaches can serve as effective strategies for introducing renewable energy concepts and sustainable waste management practices within educational settings. Future programs are encouraged to incorporate long-term follow-up evaluations to assess the sustainability of knowledge retention and the adoption of aromatic biobriquette practices in participants' daily lives.

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