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Empowering communities through sustainable innovation: transforming Coconut Shell waste into economic and environmental solutions

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Abstract: *The management of coconut shell waste is often overlooked by rural communities, despite its significant economic and environmental potential when properly processed. This community service program aimed to empower the residents of Tanete Village, Cina District, through innovative processing of coconut shell waste into Coco charcoal. The methods employed included socialization, intensive training, and mentoring. The community was trained to produce Coco charcoal using techniques such as carbonization, grinding, binder mixing, compaction, and briquette drying. Evaluation was conducted through pretests and posttests to measure technical understanding and skills before and after the training. The results showed a significant improvement, with the average posttest score reaching 82.3, compared to a pretest average of 52.3. This program had a positive impact by enhancing the community's skills in utilizing coconut waste, creating new economic opportunities, and reducing environmental pollution. Additionally, the Coco charcoal innovation contributed to reducing the carbon footprint through the use of environmentally friendly alternative energy. The outcomes of this initiative not only promoted the development of a local economy based on village resources but also supported sustainable development goals, particularly in clean energy and climate action. With these promising results, the program has the potential to be replicated in other areas as a model of sustainable, local resource-based community empowerment.*

Keyword: *Coco charcoal Innovation, Sustainable Waste Management, Community Empowerment, Zero Waste Economy, Renewable Energy Solutions*

Abstrak: *Pengelolaan limbah tempurung kelapa sering kali diabaikan oleh masyarakat desa, padahal limbah ini memiliki potensi ekonomi dan lingkungan yang besar jika diolah dengan tepat. Kegiatan Pengabdian Kepada Masyarakat ini bertujuan untuk memberdayakan masyarakat Desa Tanete, Kecamatan Cina, melalui inovasi pengolahan limbah tempurung kelapa menjadi Coco charcoal. Metode yang digunakan meliputi sosialisasi, pelatihan intensif, dan pendampingan. Masyarakat dilatih untuk memproduksi Coco charcoal menggunakan teknik karbonisasi, penggilingan, pencampuran bahan pengikat, pemadatan, dan pengeringan briket. Evaluasi dilakukan melalui pretest dan posttest untuk mengukur pemahaman dan keterampilan teknis sebelum dan sesudah pelatihan. Hasil menunjukkan peningkatan yang signifikan, di mana skor rata-rata posttest mencapai 82,3, meningkat dari skor rata-rata pretest sebesar 52,3. Program ini memberikan dampak positif berupa peningkatan keterampilan masyarakat dalam memanfaatkan limbah kelapa, menciptakan peluang ekonomi baru, dan mengurangi pencemaran lingkungan. Selain itu, inovasi Coco charcoal berkontribusi pada pengurangan jejak karbon melalui penggunaan energi alternatif yang ramah lingkungan. Hasil kegiatan ini tidak hanya mendorong pengembangan ekonomi lokal berbasis sumber daya desa, tetapi juga mendukung tujuan pembangunan berkelanjutan, khususnya terkait dengan energi bersih dan tindakan terhadap perubahan iklim. Dengan keberhasilan ini, program memiliki potensi untuk direplikasi di wilayah lain sebagai model pemberdayaan masyarakat berbasis sumber daya lokal yang berkelanjutan*

Kata kunci: *Inovasi Coco charcoal, Pengelolaan Limbah Berkelanjutan, Pemberdayaan Masyarakat, Ekonomi Zero Waste, Solusi Energi Terbarukan*

INTRODUCTION

Coconut shell waste is one of the challenges faced by communities in coconut-producing villages such as Tanete Village, Cina District, South Sulawesi. Coconut shells generated from coconut processing activities are often regarded as leftover materials that have no economic value, so they are discarded or burned. This practice not only causes environmental pollution but also ignores the great potential contained in the coconut shell (Arief et al., 2023; Mardesci et al., 2021). For instance, the processing of coconut water and meat leads to the annual generation of approximately 1,400,980 tons of coconut shells. These shells have a slow degradation rate and, when mismanaged—whether through direct disposal or open burning—cause environmental pollution with implications for human health (MDPI, 2023). In fact, with the right technology, this waste can be converted into high-value products (Ambarsari et al., 2023). One of the most promising products is Coco charcoal (charcoal briquettes from coconut shells), which offers both economic and environmental benefits.

Innovation in processing coconut shell waste into Coco charcoal is one of the sustainable solutions that can solve two main problems: waste management and community economic empowerment. Coco charcoal as an alternative fuel not only offers environmentally friendly energy, but also provides new economic opportunities for villagers involved in the production process (Saputro et al., 2023). The product has a competitive selling value, both in domestic and international markets, especially in an era that is increasingly concerned with green energy and cleaner fuels (Pranowo et al., 2021). Furthermore, this innovation directly supports Sustainable Development Goals (SDGs), particularly in promoting clean energy (Goal 7) and climate action (Goal 13), making it highly relevant for both local and global contexts.

The processing of coconut shells into Coco charcoal is an innovation that is very relevant to efforts to implement the concept of zero waste, where all parts of the coconut can be maximally utilized. The carbonization process of coconut shell to produce Coco charcoal produces fuel that has advantages in terms of combustion power, low emissions, and long shelf life (Gobel & Arief, 2022; Nurhilal & Suryaningsih, 2018; Yanti & Pauzan, 2020). This makes Coco charcoal an ideal alternative to replace environmentally unfriendly fossil fuels (Muhammad et al., 2018; Mustain et al., 2021). The Food and Agriculture Organization (FAO, 2021) estimates that traditional wood energy, including fuelwood and charcoal, emits between 1–2.4 gigatons of carbon dioxide equivalent annually, contributing 2–7% of total anthropogenic greenhouse gas emissions. Transitioning to more efficient biomass energy systems, such as those utilizing biochar, could mitigate a portion of these emissions. This makes Coco charcoal an ideal alternative to replace environmentally unfriendly fossil fuels.

This community service program is designed with an innovative approach that aims to empower the community of Tanete Village, Cina Subdistrict, especially the Wanua Cina Farmer Group (Poktan) partners through the introduction of coconut waste processing technology that is easy to implement. In this training, the community was trained to produce Coco charcoal from coconut shell waste using a simple yet effective method. Each stage of production, from shell collection, carbonization process, to briquette compaction, is taught with practical methods so that the community can easily apply it in their daily activities.

This innovation in coconut waste processing is not only relevant in the context of improving the local economy, but also as part of a sustainable solution in addressing

environmental issues. The resulting Coco charcoal is not only cleaner compared to conventional fuels such as firewood or coal, but also reduces the carbon footprint and supports the global agenda on climate change mitigation (Shalih, 2019). Through this approach, the program not only addresses local issues but also contributes to the achievement of sustainable development goals (SDGs), particularly related to clean energy and climate action (Yastika et al., 2023).

The development of Coco charcoal products is also one of the concrete steps in empowering village communities through sustainable innovation. By processing abundant waste into high-value products, partners can increase their income and create independent small businesses (Karaca & Dincer, 2021; Ngbede et al., 2019). In addition, these products also have broad market potential, especially in the industrial and household sectors that require environmentally friendly fuels. Awareness of the importance of environmentally friendly product innovation and sustainable solutions is the main foundation of this program. Coco charcoal as a result of coconut shell waste processing not only provides direct benefits to the environment and community, but also creates an empowerment model that can be replicated in other villages. Through the active involvement of the community in every stage of production, it is expected to create economic independence based on abundant local resources (Leong et al., 2021; Prandecki, 2014). Through this service, product innovations such as Coco charcoal are expected to be the driving force for a greener and more sustainable village economic transformation. This Community Service not only focuses on improving the technical skills of the community, but also on strengthening their capacity to develop environmentally friendly coconut waste-based businesses.

METHOD

The implementation of the community service program in the innovation of processing coconut shell waste into Coco charcoal in Tanete Village, Cina District uses a participatory approach, where the community is actively involved in every stage of the activity. This participatory method has been proven effective in community empowerment programs because it provides a sense of ownership of the activities carried out, so that the impact of the program is more sustainable (Ishom et al., 2021; Setyoadi et al., 2023; Wahyuni et al., 2022). The methods applied include training, hands-on practice, and intensive mentoring to ensure the successful application of the skills taught (Pathony, 2020; Sany, 2019). The program is designed to maximize community involvement in the coconut shell waste processing process so that they are able to produce Coco charcoal independently and sustainably.

Training and Socialization

The initial stage of the activity began with socialization to the village community about the economic potential of Coco charcoal and the importance of zero waste coconut waste processing. This socialization is very important to provide the community with a basic understanding of the potential of the product and its environmental impact (Asfar et al., 2023; Fajar et al., 2023). The zero waste approach has been proven effective in changing people's mindset from waste disposal to sustainable waste management (Aisyah, et al., 2023). This socialization was followed by intensive training consisting of several sessions, namely:

- **Coconut Shell Collection and Selection:** Residents are trained to identify the ideal coconut shells to be processed into Coco charcoal, as well as how to collect the raw

materials efficiently. Proper selection of raw materials is essential to produce high-quality Coco charcoal (Imansyah et al., 2024).

- **Carbonization Process:** In this session, residents were taught coconut shell carbonization techniques using a simple carbonization drum. This process involves burning the shells under minimal oxygen conditions to produce charcoal (Yanti & Pauzan, 2020).
- **Grinding and Mixing:** After carbonization, the coconut shells that have become charcoal are ground into fine particles. Community members are trained to mix the ground charcoal with a binder, such as tapioca starch, to ensure the briquettes are dense and strong (Milya et al., 2023).
- **Compacting and Forming Briquettes:** The next process is the compaction of the charcoal and binder mixture using a briquette press. The training covers how to compact the briquettes evenly so that the resulting product has good quality and durability. Good compaction is important to maintain the quality and durability of the briquettes, and make them more competitive in the market. (Setiowati & Tirono, 2014).
- **Drying and Packaging:** Residents are taught how to dry the compacted briquettes, either through natural drying in the sun or with a simple drying oven. Good packaging is also an important part of an effective marketing strategy (Muhammad et al., 2018). Once dry, the briquettes are packaged ready for commercialization.

Mentoring and Evaluation

After the training is completed, mentoring is carried out to ensure that residents are able to apply the skills they have learned. Mentoring is an important step to ensure the long-term success of the community empowerment program (Adiansyah et al., 2023; A. Asfar et al., 2023; Bonita et al., 2024). Assistance includes technical assistance in the use of tools, handling production problems, and improving product quality. The service team also conducts periodic evaluations to assess the improvement of the community's ability to produce Coco charcoal and its economic impact. Periodic evaluations are conducted to assess the improvement of the community's ability to produce products and their economic impact.

Data Collection

The data in this program was collected through two main methods:

- **Field Observation:** The team conducted direct observations during the training and Coco charcoal production process to observe partner participation, understanding of the techniques taught, and the success of the production process (Tunde et al., 2013).
- **Interviews and Focus Group Discussions (FGDs):** partners were interviewed about their experiences during the program, perceived benefits, and constraints faced in the Coco charcoal production process (Renosori et al., 2020).
- **Measurement of Production Results:** The evaluation was conducted by measuring the quantity of Coco charcoal briquettes produced by the partners after the training as well as the quality of the briquettes (Asfar et al. 2021).

Data Analysis

The data obtained were analyzed qualitatively and quantitatively. Qualitative analysis was used to assess the level of understanding and skills of the community in the Coco charcoal production process, as well as the social impact of this activity. Meanwhile, quantitative

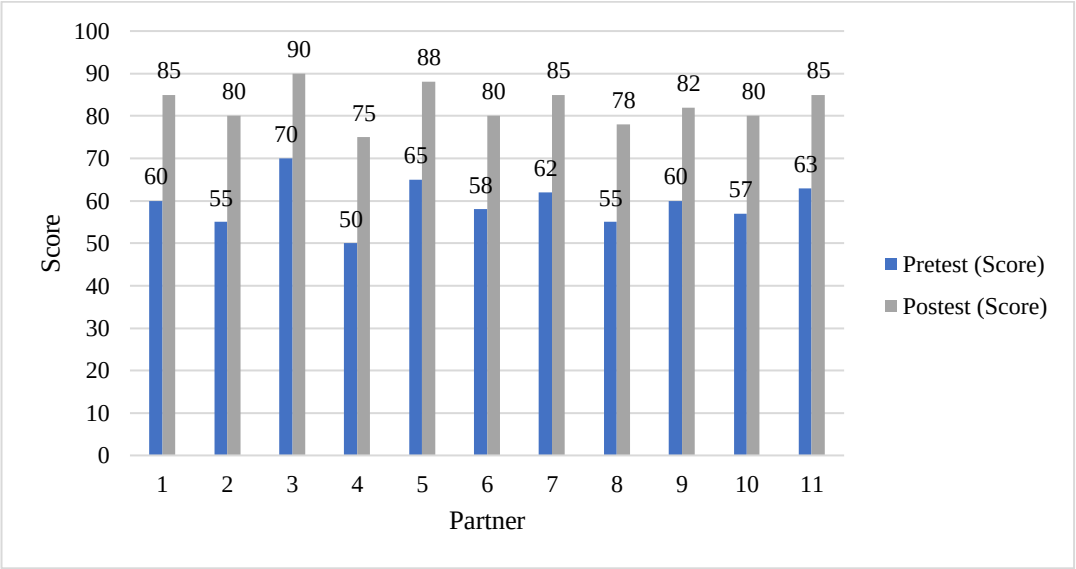
analysis was carried out to analyze the improvement before and after each stage of implementation followed by partners.

RESULTS AND DISCUSSION

RESULTS

The implementation of a community service program that focuses on the innovation of processing coconut shell waste into Coco charcoal in Tanete Village, Cina Sub-district, has shown significant results, both in terms of improving the skills of residents and the economic potential generated. The program actively involved villagers through intensive training and mentoring aimed at equipping them with new skills relevant to local potential. During the training, most partners were able to master important techniques in the Coco charcoal production process, from carbonization of coconut shells, milling, mixing with binders, to compaction and drying of Coco charcoal briquettes.

In the socialization session, a pretest was conducted to measure partners' initial understanding of Coco charcoal innovation as a sustainable solution from coconut waste. Based on the pretest results, the average partner score was 60 out of a total of 100 points, indicating that most partners had limited knowledge of the concept of zero waste, the utilization of coconut shell waste, and the benefits of Coco charcoal as an alternative fuel. This basic understanding indicates a gap in the community's knowledge before the program began, which is also an important foundation for designing targeted socialization. The following are the results of the pretest and posttest during the socialization session for the 11 partners of Poktan Wanua Cina in Graph 1.



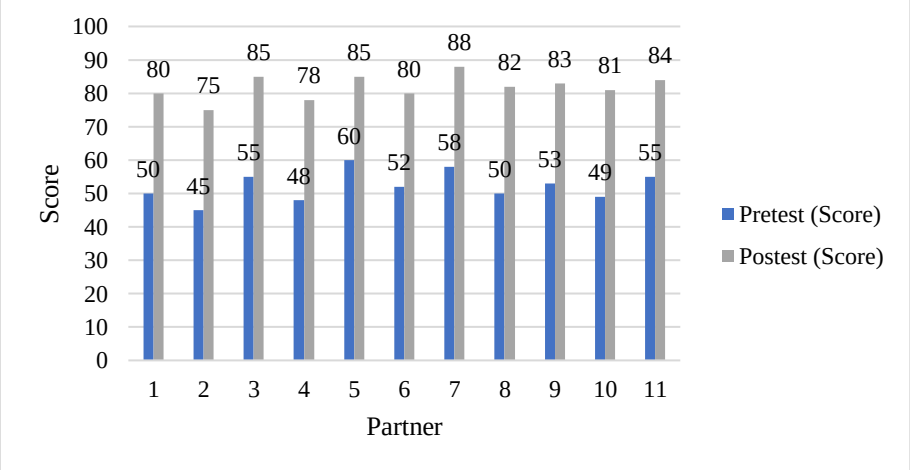
Graph 1. Partners' Understanding Before and After Socialization Session

After socialization, a posttest was conducted to evaluate the improvement of partners' understanding. The posttest results showed a significant improvement, with the average score reaching **81.3**. This increase of **21.3 points** indicates that the socialization succeeded in improving partners' understanding of the importance of sustainable coconut waste processing, the Coco charcoal production process, and its environmental and economic impacts. The

posttest results showed that the partners' understanding increased, with a range of improvement between 20 to 25 points, indicating that the socialization material was delivered effectively and well understood by all partners.

Figure 1. Socialization and Counseling of Poktan Wanua Cina Partners

During the training session, a pretest was also conducted to measure the partners' level of technical understanding before the training. The pretest results showed that the average score of the partners was **52.3**, reflecting that most partners had low technical knowledge related to the Coco charcoal production process, ranging from coconut shell carbonization, charcoal grinding, binder mixing, to packaging techniques. The small variation in scores between partners indicates that their initial understanding was relatively uniform. The following are the results of the pretest and posttest in the training session for the 11 partners of Poktan Wanua Cian in Graph 2.



Graph 2. Partners' Knowledge and Skills Before and After the Training

After the training, the posttest results showed a significant improvement in understanding, with the average score increasing to **82.3**, reflecting an average improvement of **30 points**. This improvement indicates that the technical training provided was effective in equipping partners with new skills. All partners experienced an increase in scores, with the range of improvement ranging from 25 to 32 points. Posttest results showed that partners' technical understanding became more uniform after the training, with consistent improvement across partners.

Figure 2. Partner Training on Coco charcoal Making

From the results of assistance and evaluation, it was found that after the partners received training, the partners managed to produce an average of 30-80 Coco charcoal briquettes per day. The products produced have good quality, with optimal solids and combustibility that meet the standards. In addition, the partners also succeeded in packaging the briquettes attractively and ready to be sold in the local market, which is expected to have an impact on the economic side of the partners later. This PKM activity also has a positive impact on the villagers' awareness of the importance of sustainable waste management. Residents who previously considered coconut shells as waste are now starting to see them as valuable resources that can be processed into high-value products. The success of this training creates motivation for the community to continue to develop Coco charcoal processing businesses independently.

DISCUSSION

The community service program that focuses on the innovation of processing coconut shell waste into Coco charcoal has a real impact on community empowerment and sustainable development. The socialization session provided the villagers with a basic understanding of the potential of coconut shells, which were previously considered as waste. The pretest results show that the average understanding of partners related to coconut waste processing is still limited, with an average score of 60. Most partners do not fully understand the concept of zero waste and the economic potential of Coco charcoal.

However, after the socialization session, the posttest results showed a significant increase, with the average score reaching 81.3. This increase shows that the socialization successfully

improved partners' understanding of Coco charcoal innovation as a sustainable coconut waste solution. The previously unfamiliar concept of waste management is now understood more clearly, and partners are beginning to see that coconut waste can be a valuable resource. The effectiveness of the delivery methods used, as well as the interaction that occurred during the socialization sessions, contributed to this increased understanding (Alouw & Wulandari, 2020; Anggraini et al., 2023). The socialization succeeded in providing an important conceptual foundation for partners in seeing the potential of coconut waste processing.

Next, in the training session, the focus shifted to improving the community's technical skills in producing Coco charcoal. The pretest results before the training showed that the partners' technical understanding was still low, with an average score of 52.3, indicating that most partners had not mastered the technical skills related to coconut shell carbonization, binder mixing, compaction, and packaging of Coco charcoal briquettes. However, after intensive training, the average posttest score increased to 82.3, indicating a 30-point increase in technical understanding. This improvement in skills is supported by the literature, which states that a hands-on, practice-based approach to training is more effective than lecture or theory-only methods (Aidhi et al., 2023; Rasmiati et al., 2022).

This improvement in technical skills proves that with the right approach, village communities can master simple yet effective technologies to utilize coconut waste. The production literacy and practical skills acquired through this training are in line with findings that direct involvement in production enhances the ability of communities to develop local resource-based products (Chairiah et al., 2023; Mardesci et al., 2019). The training not only equipped them with relevant technical skills, but also opened up independent business opportunities. Poktan Wanua Cina partners are now able to produce market-ready Coco charcoal briquettes, demonstrating that their technical skills have improved. The success of the program also opens up opportunities for them to develop local resource-based businesses that are environmentally friendly. Demand for Coco charcoal in the domestic market, especially among industries and households that require clean alternative fuels, continues to increase, providing real economic potential for the community.

In addition to economic improvement, Coco charcoal innovation also plays a role in reducing the environmental impact of coconut shell waste. Prior to this program, coconut shells were often discarded or burned without proper management, causing air pollution and environmental damage. Research shows that open burning of coconut waste contributes to significant air pollution (Adeniran et al., 2024; Sharma et al., 2019). while processing into Coco charcoal can drastically reduce these negative impacts (Elehinafe et al., 2022; Ho & Adnan, 2021). Through proper processing, this waste is now transformed into a useful product, thus not only providing economic benefits to the community, but also contributing to environmental conservation. This program provides a clear example that simple innovations can have a holistic positive impact, both in terms of the economy and the environment. This is in line with studies stating that processing organic waste into alternative fuels is a sustainable solution in protecting the environment (Jayarathne et al., 2018; Pathak et al., 2023).

Overall, this community service program succeeded in empowering the community by providing new skills and knowledge in utilizing local resources that were previously neglected. This is in line with the literature which states that local resource-based empowerment can

encourage sustainable village economic growth (Asfar et al., 2022; Rasyid & Nasution, 2021). The economic and environmental impacts of this program illustrate that community-based innovation plays a key role in sustainable development, as this approach not only empowers communities, but also encourages the efficient use of local resources. Through involving communities in the innovation process, they can identify and develop solutions that suit their local needs and context. This is in line with the literature showing that community-driven innovation can improve competitiveness and economic performance (Nanda Hidayati et al., 2023; Wiwoho, 2019). Given the opportunities opened up and the challenges faced, the program shows great potential for further development in the future. This success also underscores the importance of collaboration between communities, academia, government and the private sector in realizing sustainable and impactful innovation.

CONCLUSION

This community service program succeeded in empowering partners of Poktan Wanua Cina, Tanete Village, Cina District, through innovation in processing coconut shell waste into Coco charcoal. Through socialization, intensive training, and mentoring methods, the community was able to master Coco charcoal production techniques, including carbonization, milling, binder mixing, compaction, and briquette drying. Evaluation results showed significant improvements in technical understanding and skills, with higher average posttest scores than pretests. The program not only improved the community's skills in utilizing coconut waste, but also opened up new sustainable economic opportunities. In addition, the Coco charcoal innovation contributes to reducing environmental pollution through a reduced carbon footprint. With these positive results, the program has the potential to be replicated in other villages as an environmentally friendly and sustainable local resource-based community empowerment model.

AUTHOR'S STATEMENT

We declare that the article entitled "Community Empowerment with Coco charcoal Product Innovation from Coconut Waste" is our original work and has never been published in any journal before.

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LITERATURE

Adeniran, J. A., Aremu, A. S., & Abdulraheem, K. A. (2024). Modelling of air emissions from open burning of municipal waste in Ilorin Metropolis, North Central Nigeria. *Environmental Quality Management*, *33*(4), 795–808.

Adiansyah, R., Asfar, A., Rianti, M., Adriani, I., Malina, A. C., & Kasmiati. (2023). Upskilling pengolahan ulva sp. seaweed pasca produksi pada kelompok pkk kelurahan toro.

Community Development Journal, *4*(6), 12288–12294.

Aidhi, A. Al, Kurnia Harahap, M. A., Rukmana, A. Y., Palembang, S. P., & Bakri, A. A. (2023). Peningkatan Daya Saing Ekonomi Melalui Peranan Inovasi. *Jurnal Multidisiplin West Science*, *20*(2), 118–134.

Aisyah, St, R., Saleh, Y., & Hippy, M. Z. (2023). Edukasi Pemanfaatan Limbah Kotoran Ternak Berbasis Zero Waste Pada Usaha Peternakan Sapi Potong Di Desa Tulabolo Barat. *Jurnal Abdi Insani*, *10*(4), 2314–2323.

Alouw, J. C., & Wulandari, S. (2020). Present status and outlook of coconut development in Indonesia. *IOP Conference Series: Earth and Environmental Science*, *418*(1), 012035. https://doi.org/10.1088/1755-1315/418/1/012035

Ambarsari, H., Suryati, T., Akhadi, D. H., Herlina, S., Hanifah, I., Hendrawati, Andriyani, R., Gafur, N. A., & Suyanti, S. (2023). The effectiveness of coconut shell charcoal and activated carbon on deodorization of sludge from ice cream industry WWTP. *IOP Conference Series: Earth and Environmental Science*, *1201*(1), 012016. https://doi.org/10.1088/1755-1315/1201/1/012016

Anggraini, S. P. A., Mahfud, M., Juliastuti, S. R., & Suprapto. (2023). Coconut Shell Liquid Smoke Production Quality from Size and Power Using Microwave-Assisted Pyrolysis. *Engineering Chemistry*, *2*, 25–33.

Arief, R. K., Armila, A., Liswardi, A., Yahya, H., Warimani, M. S., & Putera, P. (2023). Coconut Shell Carbonization Process Using Smokeless Kiln. *Journal of Applied Agricultural Science and Technology*, *7*(2), 82–90.

Asfar, A., Adiansyah, R., Asfar, A., & Zailan, A. (2023). *Olah Limbah Pisang dengan Konsep Zero Waste*. CV Jejak (Jejak Publisher).

Asfar, A., Asfar, A., Thaha, S., Kurnia, A., Budianto, E., & Syaifullah, A. (2021). Bioinsektisida Cair Berbasis Sekam Padi Melalui Pemberdayaan Kelom Pok Tani Pada Elo ' Desa Sanrego. *Jurnal Masyarakat Mandiri*, *5*(6), 5–12.

Asfar, A. M. I. T., Nur, S., Asfar, A. M. I. A., Asfar, A. H., Nurannisa, A., & Sudartik, E. (2022). Pemberdayaan masyarakat melalui pengolahan teh dan kopi beras khas Ketan Hitam di Desa Latellang Kabupaten Bone. *ABSYARA: Jurnal Pengabdian Pada Masyarakat*, *3*(2), 255–266.

Bonita, A. F. H., Asfar, A. M. I. T., Asfar, A. M. I. A., Syaifullah, A., & Cakra, A. R. S. (2024). Plant Growth Promoting Rhizobacter as an Alternative Liquid Organic Fertilizer Based on Bamboo Roots. *Bubungan Tinggi: Jurnal Pengabdian Masyarakat*, *6*(2), 375. https://doi.org/10.20527/btjpm.v6i2.10359

Chairiah, A., Dharmawan, A. D., Rahail, J., Dewin, N. S., & Perdana, D. A. (2023). Pengembangan Potensi Pertanian Perkotaan di Kampung Sayur Bausasran Danurejan melalui Community-based Approach. *PESIRAH: Jurnal Administrasi Publik*, *1*(2), 9–15.

Elehinafe, F. B., Okedere, O. B., Ayeni, A. O., & Ajewole, T. O. (2022). Hazardous Organic Pollutants from Open Burning of Municipal Wastes in Southwest Nigeria. *Journal of Ecological Engineering*, *23*(9), 288–296.

Fajar, H. R., Asfar, A., Syahrir, M., Yasser, M., Mukhsen, M., Asfar, A., & Rifai, A. (2023). Potensi Limbah Hijauan Sebagai Pakan Ternak Alternatif Melalui Fermentasi Alami. *Communnity Development Journal*, *4*(6), 12274–12280.

Food and Agriculture Organization. (2021). *The contribution of wood energy to sustainable development goals and climate change mitigation*. Open Knowledge Repository. Retrieved from https://openknowledge.fao.org

Gobel, A. P., & Arief, A. T. (2022). Pengaruh Karbonisasi Terhadap Karakteristik Tempurung Kelapa Berdasarkan Uji Proksimat Dan Nilai Kalor. *Jurnal Mineral, Energi, Dan Lingkungan*, *5*(1), 48.

Ho, Z. H., & Adnan, L. A. (2021). Phenol Removal from Aqueous Solution by Adsorption Technique Using Coconut Shell Activated Carbon. *Tropical Aquatic and Soil Pollution*, *1*(2), 98–107.

Imansyah, F., Arsyad, M. I., & Sujana, I. (2024). Implementasi Mesin Pengurai Sabut Kelapa Untuk Optimalisasi Pemanfaatan Limbah Sabut Kelapa Menjadi Cocopeat Dan Cocofiber Guna Mendorong Perekonomian Dusun Karya Tani Desa Jeruju Besar. *Jurnal Abdi Insani*, *11*(1), 318–330.

Ishom, M., Raharjo, K. M., Sucipto, Zulkarnain, Avrilianda, D., & Fatihin, M. K. (2021). The Role of Facilitators in Community Empowerment Based on Learning Community to Improve Vocational Skills. *Proceedings of the International Conference on Information Technology and Education (ICITE 2021)*, *609*, 156–159.

Jayarathne, T., Stockwell, C. E., Bhave, P. V., Praveen, P. S., Rathnayake, C. M., Md Islam, R., Panday, A. K., Adhikari, S., Maharjan, R., Douglas Goetz, J., Decarlo, P. F., Saikawa, E., Yokelson, R. J., & Stone, E. A. (2018). Nepal Ambient Monitoring and Source Testing Experiment (NAMaSTE): Emissions of particulate matter from wood-and dung-fueled cooking fires, garbage and crop residue burning, brick kilns, and other sources. *Atmospheric Chemistry and Physics*, *18*(3), 2259–2286.

Karaca, A. E., & Dincer, I. (2021). A perspective on sustainable energy research efforts in Canada. *International Journal of Energy Research*, *45*(2), 1161–1169.

Leong, H. Y., Chang, C.-K., Khoo, K. S., Chew, K. W., Chia, S. R., Lim, J. W., Chang, J.-S., & Show, P. L. (2021). Waste biorefinery towards a sustainable circular bioeconomy: a solution to global issues. *Biotechnology for Biofuels*, *14*(1), 87.

Mardesci, H., Santosa, Nazir, N., & Hadiguna, R. A. (2019). Identification of Prospective Product for the Development of Integrated Coconut Agroindustry in Indonesia. *International Journal on Advanced Science Engineering and Information Technology*.

Mardesci, H., Santosa, Nazir, N., & Hadiguna, R. A. (2021). Analysis of Value-Added and Calculation of Production Cost in the Production of Processed Coconut Product. *International Journal on Advanced Science, Engineering and Information Technology*, *11*(2), 776–782.

MDPI. (2023). *Sustainability: Utilization of coconut processing waste - Coconut shell charcoal production*. Retrieved from https://www.mdpi.com/2071-1050/16/7/3066

Milya, C., Kurniawan, E., Hakim, L., Dewi, R., & Muhammad, M. (2023). Pembuatan Briket Cangkang Kelapa Sawit Menggunakan Variasi Jenis Dan Persentase Perekat Tepung Tapioka Dan Tepung Beras. *Chemical Engineering Journal Storage (CEJS)*, *3*(4), 505.

Muhammad, D. R. A., Parnanto, N. H. R., & Widadie, F. (2018). Kajian Peningkatan Mutu Briket Arang Tempurung Kelapa Dengan Alat Pengering Tipe Rak Berbahan Bakar Biomassa. *Jurnal Teknologi Hasil Pertanian*, *6*(1), 23–26.

Mustain, A., Sindhuwati, C., Wibowo, A. A., Estelita, A. S., & Rohmah, N. L. (2021). Pembuatan Briket Campuran Arang Ampas Tebu dan Tempurung Kelapa sebagai Bahan Bakar Alternatif. *Jurnal Teknik Kimia Dan Lingkungan*, *5*(2), 100–106.

Nanda Hidayati, Esti Handayani, & Sulistyowati, N. W. (2023). Inovasi Berkelanjutan: Pendekatan Kolaboratif untuk Mengatasi Tantangan Sosial-Ekonomi di Provinsi Jawa Barat. *Jurnal Pengabdian West Science*, *2*(6), 460–467.

Ngbede, D. E., Ahmadu, U., Gana, M., & Attah, F. (2019). Bioconversion of agricultural and industrialised waste to generate valuable products. *Brazilian Journal of Biological Sciences*, *6*(14), 599–604.

Nurhilal, O., & Suryaningsih, S. (2018). Karakterisasi Biobriket Campuran Serbuk Kayu Dan Tempurung Kelapa. *Jurnal Material Dan Energi Indonesia*, *7*(02), 13.

Pathak, G., Nichter, M., Hardon, A., Moyer, E., Latkar, A., Simbaya, J., Pakasi, D., Taqueban, E., & Love, J. (2023). Plastic pollution and the open burning of plastic wastes. *Global Environmental Change*, *80*.

Pathony, T. (2020). Proses Pemberdayaan Masyarakat Melalui Gerakan Pemberdayaan dan Kesejahteraan Keluarga (PKK) di Kabupaten Subang. *International Journal of Demos*, *1*(2), 262–289.

Prandecki, K. (2014). Theoretical Aspects of Sustainable Energy. *Energy and Environmental Engineering*, *2*(4), 83–90.

Pranowo, D., Savira, T. D., Perdani, C. G., & Setyawan, H. Y. (2021). Characteristics of Briquette as an Alternative Fuel Made of Mixed-Biomass Waste (Dairy Sludge and Coconut Shell). *Proceedings of the International Conference on Innovation and Technology (ICIT 2021)*, *212*. https://doi.org/10.2991/aer.k.211221.020

Rasmiati, R., Jafar, M., Asfar, A. M. I. T., Asfar, A. M. I. A., Ekawati, V. E., & Riska, A. (2022). Pemberdayaan kelompok Karang Taruna Desa Pitumpidange melalui pembuatan Pasta Gigi ramah lingkungan. *ABSYARA: Jurnal Pengabdian Pada Masyarakat*, *3*(2), 288–297.

Rasyid, A., & Nasution, B. (2021). Effects of corporate social responsibility communications on community empowerment in Pekanbaru. *Linguistics and Culture Review*, *6*(S3), 12–23.

Renosori, P., Prasetyaningsih, E., Selamat, S., & Nurahman, A. A. (2020). Empowerment of Housewives and Teenagers in Albinaa Madrasa Sukarasa Village, Arjasari Sub-District Bandung Regency. *Proceedings of the 2nd Social and Humaniora Research Symposium (SoRes 2019)*, 69–73.

Sany, U. P. (2019). Prinsip-Prinsip Pemberdayaan Masyarakat Dalam Perspektif Al Qur'an. *Jurnal Ilmu Dakwah*, *39*(1), 32.

Saputro, W., Faizin, A. K., & Sari, T. P. (2023). Implementasi Teknologi Pengolah Limbah Sabut Kelapa Menjadi Cocofiber dan Cocopeat di Desa Lenteng Timur, Sumenep. *Warta LPM*, 345–354.

Setiowati, R., & Tirono, M. (2014). Pengaruh Variasi Tekanan Pengepresan Dan Komposisi Bahan Terhadap Sifat Fisis Briket Arang. *Jurnal Neutrino*, *7*(1), 23.

Setyoadi, S., Kartika, A. W., Hayati, Y. S., & Setiowati, C. I. (2023). Community empowerment program to increase individual empowerment of cadres in stunting prevention. *Jurnal*

Aisyah : Jurnal Ilmu Kesehatan, *8*(2), 1097–1104.

Shalih, O. (2019). Strategi Pengelolaan Risiko Bencana Akibat Perubahan Iklim di Indonesia. In *Solusi Alumni UI untuk Indonesia* (Vol. 1). https://doi.org/10.31227/osf.io/ursb8

Sharma, G., Sinha, B., Pallavi, Hakkim, H., Chandra, B. P., Kumar, A., & Sinha, V. (2019). Gridded Emissions of CO, NOx, SO2, CO2, NH3, HCl, CH4, PM2.5, PM10, BC, and NMVOC from Open Municipal Waste Burning in India. *Environmental Science and Technology*, *53*(9), 4765–4774.

Tunde, A., Adeleke, E., & Adeniyi, E. (2013). Impact of Charcoal Production on the Sustainable Development of Asa Local Government Area, Kwara State, Nigeria. *African Research Review*, *7*(2), 1–15.

Wahyuni, N., Asfar, A. M. I. T., Asfar, A. M. I. A., Asrina, A., & Ishak, A. T. (2022). Pendampingan pengolahan limbah Kulit Kacang sebagai alternatif pupuk organik. *ABSYARA: Jurnal Pengabdian Pada Masyarakat*, *3*(2), 267–276. https://doi.org/10.29408/ab.v3i2.6575

Wiwoho, G. (2019). Orientasi Pasar Dan Inovasi Produk, Serta Pengaruhnya Terhadap Keunggulan Bersaing Dan Kinerja Perusahaan Pada Umkm: Sebuah Agenda Penelitian. *Fokus Bisnis : Media Pengkajian Manajemen Dan Akuntansi*, *18*(2), 29–38.

Yanti, I., & Pauzan, M. (2020). Analisa nilai kalor dan karakteristik pembakaran biobriket campuran sekam padi dan tempurung kelapa pada temperatur optimum karbonisasi. *Jurnal Teknik Kimia*, *26*(3), 88–94.

Yastika, P. E., Vipriyanti, N. U., Partama, I. G. Y., Suparwata, I. W. E., & Sudiarta, I. K. (2023). Analisis Respon Petani Terhadap Perubahan Iklim dan Curah Hujan di Subak Jatiluwih, Tabanan Bali, Indonesia. *Agro Bali : Agricultural Journal*, *6*(3), 783–792.