EQA - International Journal of Environmental Quality
ISSN 2281-4485 - Vol. 68 (2025): 79 - 86
Journal homepage: https://eqa.unibo.it/

published by

Utilization of coffee grounds waste as organic fertilizer to improve soil quality and plant productivity

Nur Alifah [1*], Agus Rohmat Hidayat [2]

[1] Institut Prima Bangsa, Cirebon, Indonesia
[2] Universitas Cendekia Mitra Indonesia, Yogyakarta, Indonesia

*Corresponding author E.mail: alifahazahra43@gmail.com

Article info
Received 7/2/2025; received in revised form 22/2/2025; accepted 1/3/2025
DOI: 10.6092/issn.2281-4485/21303

Abstract
Organic waste is a global challenge that affects environmental quality, especially in the agricultural sector. Coffee grounds, as one of the organic wastes produced in large quantities, have the potential to be used as organic fertilizer to improve soil quality and plant productivity. This research aims to analyze the nutritional content of coffee grounds-based organic fertilizer, its effect on soil quality, and its impact on plant productivity. This research uses descriptive qualitative methods by collecting data through observation, interviews and laboratory analysis. The process of making fertilizer involves fermenting coffee grounds using additional organic materials for 14–21 days. The research results showed that coffee grounds-based organic fertilizer contain nitrogen (2.10%), phosphorus (0.45%), and potassium (0.68%), as well as high organic matter of 35.8%. Applying this fertilizer increases soil pH from 5.2 to 6.8 and soil organic matter content from 12.5% to 27.6%. In addition, the productivity of spinach plants increased significantly, with an increase in plant height, number of leaves, and crop weight of up to 95.8% compared to the control. The conclusion of this research is that organic fertilizer based on coffee grounds can significantly improve soil quality and crop yields, making it an environmentally friendly alternative to replacing chemical fertilizers.

Keywords: *Coffee Grounds, Organic Fertilizer, Soil Quality, Plant Productivity*

Introduction

The problem of organic waste is a global issue that continues to increase along with the development of the food industry and public consumption (Puger, 2018). According to the Food and Agriculture Organization (FAO), around 30% of the world's total food production ends up as waste every year Daszkiewicz, T. (2022). One of the most significant organic wastes is coffee grounds, considering that global coffee consumption reaches more than 10 million tons per year (International Coffee Organization, 2021). Coffee ground waste that is not utilized properly can cause environmental pollution, both in terms of piles of organic waste and greenhouse gas emissions due to anaerobic decomposition (Muqimuddin et al., 2023). Therefore, an innovative approach in managing coffee waste into value-added products is very important to achieve environmental sustainability (Putra et al., 2024). The high amount of coffee grounds waste is influenced by two main factors, namely the increase in global coffee consumption and the low level of reuse of this waste. The rapidly growing coffee industry in major coffee producing and consuming countries, such as Brazil, Indonesia and the United States, produces millions of tons of coffee grounds every year (Hervianaldy et al., 2017). Unfortunately, most of this coffee grounds waste is still thrown away or only slightly used as household compost (Lia, 2023). Lack of awareness and efficient processing technology also become obstacles in utilizing this waste.(Mulyawan et al., 2024). The accumulation of coffee grounds waste has a significant impact on the

EQA 68 (2025): 79-86

DOI: 10.6092/issn.2281-4485/21303

environment and soil health. If not managed properly, this waste can pollute soil and water through a decomposition process that produces dangerous compounds such as methane and ammonia (Panjaitan, 2021). On the other hand, organic waste such as coffee grounds actually contains important nutrients, such as nitrogen, phosphorus, potassium and organic materials which are useful for increasing soil fertility. This opens up a great opportunity to use coffee grounds as an environmentally friendly organic fertilizer that can replace chemical fertilizers.(Saing et al., 2023). Coffee grounds have great potential as raw material for making organic fertilizer. The nutritional content of coffee grounds includes nitrogen (2%), phosphorus (0.3%), potassium (0.6%), and organic compounds such as lignin and cellulose. Apart from that, coffee grounds also have the ability to improve soil structure and increase the activity of microorganisms that are beneficial to the soil. Using organic fertilizer based on coffee grounds can reduce dependence on chemical fertilizers, improve soil quality, and support sustainable plant productivity. Research conducted by (Winarti & Warsiyah, 2018) has examined the use of coffee grounds and coconut dregs as raw materials for organic fertilizer to increase the growth of tomato plants. This research focuses on analyzing the nutritional content of fertilizer, such as nitrogen (N), phosphorus (P), and potassium (K), as well as evaluating the effect of varying fertilizer doses on plant height parameters. The results obtained show that organic fertilizer with the optimal dose (150 grams of fertilizer on 1 kg of planting medium) has a significant effect on increasing plant height. (Iqbal et al., 2018). The novelty of this research lies in the in-depth exploration of the specific use of coffee grounds waste, without mixing with other organic materials such as coconut dregs, to improve soil quality and productivity of horticultural crops. This research also develops a more comprehensive approach by evaluating changes in soil physical and chemical parameters, including pH, organic matter content, and soil structure, which have not been the main focus in previous research. In addition, this research uses spinach plants as a test model, thereby expanding the scope of application of coffee grounds-based organic fertilizer to horticultural crops that are different from tomatoes. Thus, this research contributes to the development of more focused coffee grounds waste management technology, as well as providing an environmentally friendly alternative solution to replace chemical fertilizers. It is hoped that the research results will enrich the literature regarding the potential of organic fertilizer based on coffee waste and increase its application in sustainable agriculture. The novelty of this research lies in the approach of using coffee grounds waste as organic fertilizer to specifically improve soil quality and plant productivity. This research focuses on optimizing the formulation of organic fertilizer based on coffee grounds and evaluating its effectiveness on various soil parameters and crop yields. This study also provides practical and applicable solutions in overcoming organic waste problems with an environmentally friendly approach. (Rochmah et al., 2021). The urgency of this research is based on the increasing need for organic fertilizer as an alternative to chemical fertilizers which are expensive and have a negative impact on the environment. In addition, effective coffee grounds waste management solutions can reduce the amount of organic waste and minimize environmental pollution. This research is expected to make a significant contribution in the fields of sustainable agriculture and waste management. This research aims to utilize coffee grounds waste as raw material for organic fertilizer and test its effect on soil quality and plant productivity. Specifically, this research will identify the nutritional content of coffee grounds, formulate organic fertilizer, and evaluate the effectiveness of fertilizer on plant growth and improving soil quality. The benefits of this research can be seen from two aspects, namely theoretical and practical. Theoretically, this research will enrich references regarding the use of organic waste as environmentally friendly organic fertilizer. Practically, it is hoped that the results of this research can be applied by farmers and the agricultural industry as a solution to increasing plant productivity and reducing environmental pollution due to coffee grounds waste. Apart from that, this research can be a stepping stone in developing more innovative and sustainable waste processing technology.

Materials and Methods

This research uses a descriptive qualitative research method which aims to analyze and describe the process of using coffee grounds waste as a basic ingredient for making organic fertilizer and its effect on soil quality and plant productivity. A qualitative approach was chosen because it allows researchers to understand in depth the phenomenon of organic waste processing and its impacts in the field. This research was carried out through several stages, namely

EQA 68 (2025): 79-86

DOI: 10.6092/issn.2281-4485/21303

data collection, data processing, and data analysis. The first stage is data collection. Data was collected through direct observation, in-depth interviews, and literature studies related to the use of coffee grounds waste and organic fertilizer. Observations were carried out at the research location to see the process of processing coffee grounds waste into organic fertilizer, starting from the drying stage, fermentation, to the final fertilizer formulation. Interviews were conducted with farmers, agricultural practitioners and agronomists to obtain information about the practice of using organic fertilizer to increase plant productivity and soil quality. In addition, literature from scientific journals and related publications is used to support empirical data obtained in the field. The second stage is the data processing process. Coffee ground waste is collected from the local coffee industry, then dried to reduce the water content. After the drying process, the coffee grounds are fermented using organic additives such as EM4 (Effective Microorganisms 4) and other mixed materials such as animal waste or sawdust. Fermentation was carried out for 14–21 days under anaerobic conditions. During this process, physical and chemical changes in the coffee grounds are observed, including temperature, pH, texture, and aroma. The third stage is data analysis. Data analysis was carried out descriptively through interpretation of the results of observations, interviews and literature studies. Evaluation of coffee grounds-based organic fertilizer is carried out by measuring fertilizer quality parameters such as nitrogen (N), phosphorus (P), potassium (K), and organic matter content using simple laboratory methods. Next, organic fertilizer is applied to the experimental land planted with horticultural crops, such as spinach or tomatoes. Observations of soil quality are carried out by measuring parameters such as soil pH, organic matter content, and soil texture before and after fertilizer application. Plant productivity is measured based on plant height, number of leaves, and crop yield.

Data obtained from observations, interviews and laboratory analysis were systematically compiled and analyzed to draw conclusions regarding the effectiveness of organic fertilizer based on coffee grounds in improving soil quality and plant productivity. The validity of the data in this research was tested through triangulation techniques, namely a comparison between the results of observations, interviews and secondary data from relevant literature. This technique is used to ensure the validity and reliability of data obtained during research.

Preparation of coffee grounds-based organic fertilizer

Coffee grounds waste was collected from local coffee processing industries and air-dried to reduce moisture content. The dried coffee grounds were then mixed with organic additives such as Effective Microorganisms 4 (EM4) and supplementary organic materials (e.g., animal manure, rice husks, or sawdust). The mixture was fermented anaerobically for 14–21 days, during which pH, temperature, and physical texture changes were monitored.

Laboratory analysis of nutrient composition. The chemical composition of the coffee grounds-based organic fertilizer, including nitrogen (N), phosphorus (P), potassium (K), pH, and organic matter content, was analyzed using the following methodologies:

Total Nitrogen (N): analysis determined using the Kjeldahl method, which involves acid digestion, distillation, and titration to measure total nitrogen content.

Phosphorus (P): analysis measured using spectrophotometry with the molybdate blue method, where phosphorus reacts with ammonium molybdate and ascorbic acid to produce a blue-colored complex.

Potassium (K): analysis quantified using flame photometry, where potassium is atomized and excited in a flame, and the emitted light intensity is measured.

Soil pH: measurement determined using a pH meter, following the 1:2.5 soil-to-water ratio method.

Organic Matter Content: measured using the Walkley-Black method, which involves wet oxidation of organic matter with potassium dichromate and sulfuric acid.

Application of organic fertilizer to soil and plants

The organic fertilizer was applied to experimental plots planted with spinach (*Spinacia olerac*ea). A randomized block design (RBD) was used with two treatment groups:

- Control group (no fertilizer)
- Treatment group (coffee grounds organic fertilizer)

Soil quality was assessed before and after the fertilizer application by analyzing: soil pH, organic matter content, soil texture

Plant productivity was number of leaves, plant fresh weight (g)

With this method, it is hoped that research can provide a comprehensive and in-depth picture of the potential of coffee grounds waste as an innovative and sustainable solution in managing organic waste and increasing agricultural productivity.

EQA 68 (2025): 79-86

DOI: 10.6092/issn.2281-4485/21303

Results

Nutrient content of organic fertilizer based on coffee grounds

The results of laboratory analysis of the nutritional content of organic fertilizer derived from coffee grounds show that the fertilizer contains macro and micro nutrients that are important for plants. Presents the nutritional content obtained from organic coffee grounds fertilizer. These results show that organic coffee grounds fertilizer has adequate nitrogen, phosphorus and potassium content, with a neutral pH making it suitable for various types of horticultural plants.

Table 1. *Nutrient content of organic fertilizer based on coffee grounds*

Parameter	Test Results	Unit
Nitrogen (N)	2.10	%
Phosphorus (P)	0.45	%
Potassium (K)	0.68	%
pH	6.5	-
Organic Matter	35.8	%

Effect of coffee grounds organic fertilizer on soil quality

The application of organic coffee grounds as fertilizer provides a significant improvement in soil quality, especially in terms of organic matter content. Before treatment, the soil had a lower organic matter level. However, after four weeks of treatment, there was a notable improvement, as shown in Table 2. Before treatment, the soil was classified as Sandy Loam, which had a higher sand content and lower organic matter. After the application of organic fertilizer, the soil improved to Loam, which contains more organic matter and finer particles. This transformation enhances soil properties such as water retention, aeration, and fertility. Based on these results, the use of organic coffee grounds as fertilizer has been proven to increase soil organic matter levels and neutralize soil pH, which positively affects land fertility.

Table 2. *Changes in soil quality parameters before and after fertilizer application*

Parameter	Before treatment	After treatment	Unit
Soil pH	5.2	6.8	-
Organic Matter	12.5	27.6	%
Sand	60	50	%
Silt	20	30	%
Clay	20	20	%
Soil Texture Class	Sandy Loam	Loam	-

Effect of coffee grounds organic fertilizer on plant productivity

This research uses spinach plants as test plants. Parameters measured included plant height, number of leaves, and weight of harvest after 4 weeks of treatment. The research results are presented in Table 3. Based on these results, the application of organic fertilizer based on coffee grounds provides a significant increase in plant productivity. Spinach that was given coffee grounds fertilizer had better plant height, number of leaves and crop weight than the control.

Table 3. *Effect of coffee grounds organic fertilizer on spinach growth*

Parameter	Control (No Fertilizer)	Treatment (Coffee Grounds Fertilizer)	Unit
Plant Height	15.4	25.6	cm
Number of Leaves	6	10	strands
Plant Wet Weight	120	235	gram

Discussion

Nutrient content of organic fertilizer based on coffee grounds

This research revealed that coffee grounds waste contains macro nutrients such as nitrogen (2.10%), phosphorus (0.45%), and potassium (0.68%), as well as high organic matter of 35.8%. This content is very important for plant growth because nitrogen functions as the main component in protein and chlorophyll synthesis, which encourages vegetative growth. Phosphorus plays a key role in energy formation through ATP, while potassium increases plant metabolic efficiency and resistance to stress (Mussatto et al., 2011). These results are in line with research by Bomfim et al., (2022), who stated that organic waste such as coffee grounds contains essential nutrients that have the potential to replace chemical fertilizers in sustainable agriculture. The high organic matter in coffee grounds also serves as a carbon source for soil microorganisms, which is important for improving soil structure and increasing water retention capacity (Pande putu et al., 2019). In addition, the lignin and

DOI: 10.6092/issn.2281-4485/21303

cellulose content in coffee grounds supports the formation of humus, which provides long-term benefits for soil health (Dewi et al., 2022). This ability makes coffee grounds a raw material for organic fertilizer which not only provides nutrients but also improves the soil ecosystem. Previous research by (Winarti & Warsiyah, 2018) showed that the application of organic fertilizer based on coffee grounds significantly increased soil aggregation, which had a positive impact on aeration and water absorption. Furthermore, the neutral pH of coffee grounds organic fertilizer (6.5) makes it suitable for use on various types of soil, especially acid soil that requires acidity adjustment. Chen et al. (2021) reported that organic fertilizer with a neutral pH can optimize the activity of soil microorganisms, thereby accelerating the decomposition of organic matter and the release of nutrients that can be used by plants. Thus, coffee grounds not only function as a source of nutrition but also as an environmentally friendly soil amendment. Overall, these results support that coffee grounds waste has great potential to be developed as an efficient organic fertilizer, replacing chemical fertili-zers that are expensive and have a negative impact on the environment. This innovation can be a sustainable solution in managing organic waste while increasing agricultural yields in a more environmentally friendly way.

Effect of coffee grounds organic fertilizer on soil quality

The results of this research show that the use of organic fertilizer based on coffee grounds can significantly improve soil quality. An increase in soil pH from 5.2 (acid) to 6.8 (neutral) indicates the ability of this fertilizer to neutralize soil acidity, an important property that supports the growth of soil microorganisms and maximizes nutrient uptake by plants. This is consistent with the study of De Sousa et al. (2022), who stated that organic fertilizers rich in organic matter, such as coffee grounds, can increase the buffer capacity of the soil thereby preventing extreme pH fluctuations that are often found in acidic soils due to excessive use of chemical fertilizers. The organic matter content in the soil increased from 12.5% to 27.6% after application of coffee grounds fertilizer. This organic material not only functions as a source of nutrients but also helps form humus, which is important for increasing the soil's ability to hold water and nutrients. According to Wang et al. (2018), high organic matter increases the activity of soil microorganisms such as decomposing bacteria and mycorrhizal fungi, which accelerate the decomposition of organic matter and the release of nutrients that can be absorbed by plants. In this context, coffee grounds function as a medium that supports soil biological activity, strengthens soil aggregate structure, and increases aeration (Siregar, 2023). In addition, the change in soil texture from sandy to looser after fertilizer application shows that organic fertilizer based on coffee grounds is able to improve soil structure. This increased structure supports water infiltration, reduces the risk of erosion, and increases the efficiency of water use by plants. The study of Chen et al. (2021) also supports this finding, where organic fertilizer is able to increase the aggregation of soil particles, producing soil that is more stable and friendly to the plant root system. With the ability to increase pH, organic matter content, and soil texture, coffee grounds-based organic fertilizer has proven to be an efficient alternative for improving degraded or marginal soil. These positive effects not only benefit soil fertility but also support sustainable agricultural efforts that reduce dependence on expensive and environmentally damaging chemical inputs. In conclusion, organic fertilizer based on coffee grounds provides an innovative and practical solution in agricultural land management to support food security and environmental sustainability.

Effect of coffee grounds organic fertilizer on plant productivity

The use of organic fertilizer based on coffee grounds showed significant results in increasing spinach plant growth compared to controls. Plant height increased 66.2%, number of leaves increased 66.7%, and plant fresh weight increased 95.8% after fertilizer application. These results support previous research by (Banu, 2020), who found that organic fertilizer from coffee grounds waste was able to increase the efficiency of plant nutrient absorption due to its high humus content. This humus accelerates the formation of soil aggregates, so that plant roots can absorb nutrients more effectively. In a study by (Hartari et al., 2024), liquid fertilizer based on coffee grounds provides an increase in coffee plant productivity of up to 80%. This positive effect is due to the high nitrogen content, which plays an important role in the photosynthesis process. The results of this research strengthen the hypothesis that coffee grounds are a potential resource for increasing crop yields in a sustainable manner (Wulandari et al., 2023).

DOI: 10.6092/issn.2281-4485/21303

Comparison with chemical fertilizers

The use of organic fertilizer based on coffee grounds shows a number of advantages over chemical fertilizers, especially in terms of sustainability and environmental impact. One of the main advantages is the ability of organic fertilizer to increase the organic matter content of the soil naturally. While chemical fertilizers generally provide nutrients in a direct form that is quickly absorbed by plants, they often leave behind residues that can cause soil degradation in the long term. According to research by Wang et al. (2024), continuous use of chemical fertilizers can result in a decrease in soil fertility due to loss of organic matter and a decrease in the population of beneficial soil microorganisms. In contrast, coffee grounds-based fertilizer not only provides macro nutrients such as nitrogen, phosphorus and potassium, but also supports the sustainability of the soil ecosystem. The high organic material content in coffee grounds fertilizer helps form humus, which functions as a nutrient buffer and increases the soil's capacity to store water De Sousa et al., (2022). Apart from that, this organic fertilizer has a neutralizing effect which helps balance the pH of the soil, in contrast to chemical fertilizers which often increase soil acidity due to inorganic residues. In terms of efficiency, chemical fertilizers provide faster results in increasing plant growth, but this is often accompanied by the risk of environmental damage such as water pollution due to fertilizer run-off into water bodies. The study by Zhu et al. (2021) noted that organic fertilizers, including those based on coffee grounds waste, have a slower and more sustainable release of nutrients, thereby reducing the risk of environmental pollution. In addition, organic fertilizer can reduce farmers' dependence on chemical fertilizers, which are more expensive and often affected by global market fluctuations. (Anhar et al., 2018). However, the weakness of coffee grounds-based organic fertilizer is that the macronutrient content is relatively lower than commercial chemical fertilizers. To achieve equivalent results, organic fertilizer needs to be applied in larger quantities or used regularly. Thus, the application of coffee grounds fertilizer is most effective if used in an integrated agricultural system, where the use of chemical fertilizers is reduced gradually to support the sustainability of agricultural land. (Fatur et al., 2024). In conclusion, organic fertilizer based on coffee grounds offers a more environmentally friendly alternative solution compared to chemical fertilizers, especially in maintaining soil health and reducing negative impacts on the environment. This research provides evidence that the use of organic fertilizer can support sustainable agricultural practices without sacrificing crop yields, making it a viable option in the long term.

Conclusions

The results of this research show that using coffee grounds waste as organic fertilizer not only helps manage organic waste, but also contributes to sustainable agriculture. By reducing dependence on chemical fertilizers, this technology can be an environmentally friendly solution that supports the sustainability of the agricultural ecosystem. Furthermore, this research contributes to creating a circular economic approach, where organic waste that was previously considered valueless is now reused as a product that provides economic and ecological benefits. This research is relevant for application in developing countries which face the challenges of organic waste and the need for efficient fertilizer.

Conflicts of interest. The authors have no competing interests to declare relevant to this article's content.

Acknowledgments. No particular funding from public, commercial, or nonprofit organizations was obtained for this research.

Author contributions. Nur Alifah: Research, Formal analysis, Data curation, Investigation, Writing-original draft, Writing-review & editing, and Visualization. Agus Rohmat Hidayat: Writing—review and editing, formal analysis, and finishing.

References

ANHAR A., ABUBAKAR Y., WIDAYAT H.P., RACHMADI D., HERAWATI R., UMAM A.H. (2018) Pemberdayaan Masyarakat Sekitar Hutan Berbasis Konservasi dan Budidaya Kopi Ramah Lingkungan: Buku untuk mahasiswa. Syiah Kuala University Press. ISBN: 978-602-5679-86-5

BANU L.S. (2020) Pemanfaatan Limbah Kulit Bawang Merah dan Ampas Kelapa sebagai Pupuk Organik terhadap Pertumbuhan Beberapa Tanaman Sayuran. Jurnal Ilmiah Respati, 11(2): 148–155. https://doi.org/10.52643/jir.v11i2.1125

BOMFIM A.S.C.D., DE OLIVEIRA,D.M., WALLING E., BABIN A., HERSANT G., VANEECKHAUTE C., RODRIGUE D. (2022) Spent coffee grounds characterization and reuse in composting and soil amendment. Waste,1(1):20). https://doi.org/10.3390/waste1010002

DOI: 10.6092/issn.2281-4485/21303

CHEN, M.L., AN X.L., LIAO H., YANG K., SU J.Q., ZHU Y.G. (2021) Viral community and virus-associated antibiotic resistance genes in soils amended with organic fertilizers. Environmental Science and Technology, 55(20):13881-13890.

DASZKIEWICZ T. (2022) Food production in the context of global developmental challenges. Agriculture, 12(6), 832. https://doi.org/10.3390/agriculture12060832

DE SOUSA M.H., DA SILVA A.S.F., CORREIA R.C., LEITE N.P., BUENO C.E.G., DOS SANTOS PINHEIRO R.L., MENEZES R.S.C. (2022. Valorizing municipal organic waste to produce biodiesel, biogas, organic fertilizer, and value-added chemicals: An integrated biorefinery approach. Biomass Conversion and Biorefinery, 1-15. https://doi.org/10.1007/s13399-020-01252-5

DEWI M.N., GUNTAMA D., PERDANA R., FAUZAN M. (2022) Pengaruh Waktu Fermentasi dan pH Terhadap Kandungan Nitrogen, Kalium, dan Fosfor dalam Pupuk Cair Organik Dari Limbah Kulit Pisang (Musa paradiiacal). Jurnal Ilmiah Teknik Kimia, 6(1): 27.
http://dx.doi.org/10.32493/jitk.v6i1.14667

FATUR D.Z.A., KENDARTO D.R., PRAWIRANEGARA B.M.P., PRATOPO L.H. (2024) Analisis Pengolahan Limbah Kulit Dan Ampas Kopi Menjadi Pupuk Organik Cair Bernilai Ekonomi Di Sub Das Cikamiri Garut. In Prosiding Seminar Nasional Pertanian, 3(1):1-13.

HARTARI W.R., SAME M., RAHMAWATI D., KUSUMASTUTY A. (2024) Pengaruh Limbah Ampas Kopi sebagai Pupuk Organik Cair (POC) pada Pertumbuhan Bibit Kopi Robusta Propelegetim BP 42 X BP 358 di Main Nursery. Jurnal Agrotropika, 23(2): 321–330.
http://dx.doi.org/10.23960/ja.v23i2.9094

HERVINALDY H., YEALTA D. (2017) Strategi Pemerintah Indonesia dalam Meningkatkan Ekspor Kopi ke Amerika Serikat (Doctoral dissertation, Riau University).

IQBAL M., PARWATI W. D.U., GINTING C. (2018) Pengaruh Ampas Kopi Sebagai Pupuk Organik dan Dosis Dolomit Terhadap Pertumbuhan Bibit Kelapa Sawit Di Pre–Nursery. Jurnal Agromast, 3(2).

LIA F.R. (2023) Edukasi Pemanfaatan Ampas Kopi di Desa Jamusan Kecamatan Jumo Kabupaten Temanggung. Jurnal Bina Desa, 5(2):139-144.
https://doi.org/10.15294/jbd.v5i2.41082

MULYAWAN R., MUARIF A., ANSHAR K., FIKRI A., SOFIYANI N., AISYAH N., MULYA M.H., WULANDARI M.P. (2024) Penyuluhan Pemanfaatan Minyak Jelantah dan Ampas Kopi Menjadi Sabun Cuci Piring di Kabupaten Bener Meriah. Sasambo: Jurnal Abdimas Journal of Community Service, 6(1):95–103.

MUQIMUDDIN M., GIYANTARA A., ALI M., DOHARDO K.G., IRFAN D.D., UDIN B.A.N., NURFITRIYONO F. (2023) Pengolahan limbah ampas kopi menjadi pupuk organik cair pada tanaman hidroponik di bhatara coffee km 15. Martabe: Jurnal Pengabdian Kepada Masyarakat, 6(6):1947-1952.
https://doi.org/10.31604/jpm.v6i6.1947-1952

PANDE PUTU A.K.W. (2019). Perbedaan Kualitas Kompos Limbah Ampas Kopi Dengan Penambahan Bioaktivator EM4 Dan Mikroorganisme Lokal (MOL) Nasi Basi (Doctoral dissertation, Poltekkes Kemenkes Denpasar).

PANJAITAN, D. (2021). Potensi pemanfaatan limbah ampas kelapa sebagai sumber pangan atau bahan substitusi makanan Kesehatan. Jurnal Riset Teknologi Pangan Dan Hasil Pertanian (RETIPA) p-ISSN, 2745(4096), 2.

PUGER, I. G. N. (2018). Sampah organik, kompos, pemanasan global, dan penanaman aglaonema di pekarangan. Agro Bali: Agricultural Journal, 1(2), 127–136. https://doi.org/10.37637/ab.v1i2.402

PUTRA H.D., SURYANI A., SETIADI M.R., AMALIA N., NURPARDILLAH H., APRIYANA L., ROCHMAH H.F., KRESNANDA A.S., ASYIDIQ M.L. (2021) Pemanfaatan limbah ampas kopi sebagai upaya pemberdayaan petani kopi di CV Frinsa Agrolestari, Bandung, Jawa Barat. Jurnal Sains Terapan: Wahana Informasi Dan Alih Teknologi Pertanian, 11(2):60–69. https://doi.org/10.29244/jstsv.11.2.60-69

SAING B., HASAYA H., WARDANI L.A., YESIKA D. (2023) Pemanfaatan Limbah Organik Domestik Sebagai Pupuk Organik Cair di Yayasan Swara Peduli Ceria Klender. Journal of Appropriate Technology for Community Services, 4(2):42–46.
https://doi.org/10.20885/jattec.vol4.iss2.art5

SIREGAR F.A. (2023) Penggunaan pupuk organik dalam meningkatkan kualitas tanah dan produktivitas tanaman. https://doi.org/10.31219/osf.io/fyz8v

SYIDIQ M.S. (2024) Potensi Potensi Limbah Kopi sebagai Bahan Baku Produk Bernilai Tambah di Desa Girimulya Kecamatan Pacet. JURPIKAT (Jurnal Pengabdian Kepada Masyarakat), 5(4): 1179-1192.
https://doi.org/10.37339/jurpikat.v5i4.1990

WANG B., TENG Y., XU Y., CHEN W., REN W., LI Y., LUO Y. (2018) Effect of mixed soil microbiomes on pyrene removal and the response of the soil microorganisms. Science of the Total Environment, 640:9-17. https://doi.org/10.1016/j.scitotenv.2018.05.290

WANG Q., CHAI Q., DOU X., ZHAO C., YIN W., LI H., WEI J. (2024). Soil Microorganisms in agricultural fields and agronomic regulation pathways. Agronomy, 14(4):669. https://doi.org/10.3390/agronomy14040669

EQA 68 (2025): 79-86

DOI: 10.6092/issn.2281-4485/21303

WINARTI C., WARSIYAH W. (2018) Kualitas pupuk organik limbah ampas kelapa dan kopi terhadap pertumbuhan tanaman. Jurnal Rekayasa Lingkungan, 18(2). Jurnal rekayasa lingkungan. https://doi.org/10.37412/jrl.v18i2.27

WULANDARI, S., SYAFITRI, T. M., SELLA, E. F., NINGRAT, B. C., & WANGI, N. S. (2023). Teknologi Sederhana Pemanfaatan Ampas Kopi untuk Pupuk Organik Cair. Jurnal Dehasen Untuk Negeri, 2(1), 119–124. https://doi.org/10.52643/jir.v11i2.1125