WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Study and Comparison of Nutrients in Coffee Grounds Fermented Water Treated with Pulsed Electric Fields.

Khemmathut Luangdang[1], Supakiat Supasin[2] and Arthitaya Kawee-AI[1]*

[1]Division of Cannabis and Medicinal Plants for Local Development, Graduate School, Payap University, Chiang Mai 50000, Thailand
[2]Faculty of Engineering, Rajamangala University of Technology Lanna, Chiang Mai 50300, Thailand.
Doi : https://doi.org/10.55248/gengpi.5.0924.2528

A B S T R A C T

This study compared the quality of coffee ground fermented liquid (CGFL) with and without pulsed electric field (PEF) treatment on the growth of mung bean seedlings. CGFL was prepared by fermenting coffee grounds with water for 10 days, with one batch treated with PEF (6 kV/cm, 1 Hz, 300 pulses) prior to fermentation. Chemical analysis showed PEF treatment reduced organic matter, organic carbon and total nitrogen by 14-17%, while increasing some mineral contents like potassium and sulfur. Both CGFLs had suitable carbon-to-nitrogen ratios (33-34) for plant growth. Mung beans were grown in soil mixed with the two types of CGFL. This suggests PEF treatment could improve the fertilizer quality of coffee ground waste for agricultural application.

Keywords: Spent Coffee Ground (SCG), Pulse Electric Fields, Compost

Introduction

Coffee grounds (Spent Coffee Grounds) are a waste product from coffee consumption (Saberian et al., 2021). Coffee grounds contain a large number of organic compounds, requiring a large amount of oxygen to effectively decompose organic structures (Cervera-Mata et al., 2022). When discarded in large quantities in landfills without treatment, they are at high risk of spontaneous combustion and releasing methane and carbon dioxide gases, as well as unpleasant odors from the composting process. Proper management of coffee grounds, such as composting or worm farming, can convert coffee grounds into a nitrogen-rich fertilizer (Saberian et al., 2021). Mixing coffee grounds with potting soil reduces the levels of magnesium, phosphorus, calcium, sodium, iron, manganese, zinc, and copper in Chinese cabbage (Cervera-Mata et al., 2019). Chamaiporn Dangtui et al. (2017) found that biofertilizers from coffee bean pulp and husks at all concentrations tested could increase the fresh weight and height of Chinese cabbage higher than the control group. The efficiency of the biofertilizer may be due to Caffeine, which has cytokinin-like effects, stimulates cell development and stem elongation. Important nutrients such as nitrogen, phosphorus, and potassium promote plant growth. In addition, mixing 5-15% coffee grounds in the soil can reduce the average germination time and increase the germination index of Chinese morning glory seeds (Matnaporn Maikami, 2021).

The objective is to compare the compounds in the coffee grounds fermented water extracted after extraction by pulse electric field technology and fermentation process. The experimental results can be used for the cultivation and utilization of coffee grounds. The test results are published as information to promote and recommend farmers to use it in their local area.

Materials and Methods

Extraction equipment

Low-cost mobile combined electric field and ultrasonic herbal extractor, as shown in Figure 1, is a prototype of a low-cost mobile combined electric field and ultrasonic herbal extractor for community enterprises from the Innovation Office, Payap University, Chiang Mai Province, Thailand

Figure 1 Low-cost mobile combined electric pulse field and ultrasonic herbal extractor.

Research method

The study looked like fermented coffee grounds without testing. The fermented coffee grounds could be tested by pulsed electric field.Method of treating coffee grounds before fermentation

Collect used coffee grounds and put them in an aluminum tray and then dry them in the sun until the humidity is reduced to approximately 50-60% (Cervera-Mata et al., 2019). Observe the impurities before collecting SCG. If any, remove them. Then weigh the coffee grounds that have been dried by baking at 50 degrees Celsius for 24 hours, 50 percent humidity, 100 grams, and put them in the treatment chamber (Chamber) of the pulse electric field machine. Then add water at a ratio of 1 to 10 using 100 grams of coffee grounds per 1,000 ml of water. Mix and stir well. Soak for about 10 minutes. Then treat with the pulse electric field technique at an electric field intensity of 6 kV/cm, frequency 1Hz, 300 pulses (Kamboj et al., 2022). After finishing, filter the sample through filter paper to separate the water and grounds. Treated coffee grounds are baked at 50 degrees Celsius for 24 hours before being fermented to produce coffee grounds fermented water.

Coffee grounds fermentation method

Produce fermented coffee grounds by modifying the fermentation method of Febrian and Masjud (2022) by putting 100 grams of coffee grounds in a fermentation tank, then adding water at a ratio of 1 to 10 and fermenting for 10 days. To analyze the amount of minerals and nutrients in the fermented water, as shown in Table 1. The compounds were analyzed using the following instruments: 1. Organic matter 2. Organic carbon 3. Total nitrogen 4. Nitrate 5. Ammonium 6. Phosphorus 7. Potassium 8. Calcium 9. Magnesium 10. Sodium 11. Iron 12. Manganese 13. Copper 14. Zinc 15. Sulfur 16. Measure the pH value with a pH meter and compare the amount of minerals and pH values with coffee grounds that have not been treated and fermented using the same method.

Table 1 Instruments used to examine compounds in fermented coffee grounds.

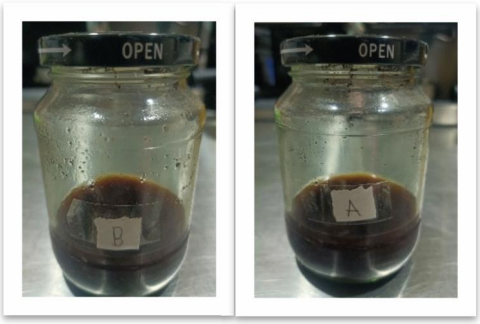
Method of analysis	**List of compounds analyzed**
Walkley & Black	Organic Matter
Calculate	Organic Carbon
Combustion	Total Nitrogen, Sulfur
KCI Extraction	Nitrate, Ammonium
Bray II Extraction	Phosphorus
AAS	Potassium, Calcium, Magnesium, Sodium, Iron, Manganese, Copper, Zinc

Results and Discussions

Study of the characteristics of untreated coffee grounds fermented water compared to coffee grounds fermented water treated with pulsed electric field technology.

In this study of coffee grounds' characteristics, coffee grounds were treated with pulsed electric field technique at an electric field intensity of 6 kV/cm, a frequency of 1 Hz, and 300 pulses according to the method of Kamboj et al. (2022). Then, the obtained coffee grounds were mixed with water in a

ratio of 1 to 10 for 10 days. The resulting coffee grounds fermented water is as shown in Figure 2. Both types of fermented water were then analyzed for mineral content. The results are shown in Table 2



(a) (b)

Figure 2 Characteristics of coffee grounds fermented water (a) untreated before fermentation and (b) fermented water from fermented coffee grounds treated with pulsed electric field.

From Figure 2, it was found that the fermented water from untreated coffee grounds before fermentation was darker than the fermented water from fermented coffee grounds treated with pulsed electric field, and the fermented water from untreated coffee grounds after fermentation had a pH value of 5.5, while the fermented water from fermented coffee grounds treated with pulsed electric field had a pH value of 5.8 It shows that the growth of microorganisms in the fermented water treated with pulsed electric field is less than that of untreated coffee grounds. The reason for the growth of a smaller number of microorganisms is because the electric current will destroy the cells of plants and microorganisms, creating permanent pores that water can pass through well and are pores that love a lot of water. The amount of molecules and ions inside the cells will be electroporated by the operation of the pulsed electric field causing them to break up. The easily observable characteristic is the lighter color.

Table 2 Content of various minerals in fermented coffee grounds water.

Compounds in fermented water	**Fermented water from untreated coffee grounds**	**Fermented water from fermented coffee grounds treated with pulsed electric field**	**Rate of change (%)**
Organic matter (%)	1.25±0.02[a]	1.04±0.01[b]	-16.80
Organic carbon (%)	0.72±0.03[a]	0.60±0.02[a]	-16.67
Total nitrogen (%)	0.021±0.00[a]	0.018±0.00[a]	-14.28
Nitrate (mg/L)	16.24±0.98[b]	18.35±0.21[a]	12.99
Ammonium (mg/L)	6.35±0.40[a]	7.76±0.93[a]	22.20
Phosphorus (mg/L)	110.15±1.82[a]	101.90±2.42[a]	-7.49
Potassium (mg/L)	177.00±2.52[a]	208.71±5.17[b]	17.92
Calcium (mg/L)	38.67±1.33[a]	31.50±2.91[b]	-18.54
Magnesium (mg/L)	28.88±1.73[a]	30.38±2.22[a]	5.19
Sodium (mg/L)	83.00±2.44[a]	83.00±3.11[a]	0
Iron (mg/L)	1.63±0.03	<1.00	-38.65
Manganese (mg/L)	0.52±0.06[a]	0.58±0.06[a]	11.54
Copper (mg/L)	<1.00	<1.00	0
Zinc (mg/L)	0.98±0.05	<0.20	-79.59
Sulfur (%)	0.17±0.00[a]	0.22±0.03[a]	29.41

Letters a and b indicate statistically significant differences at 0.05 between the two experimental groups, compared using the independent t-test, where (+) and (-) are the means of the two tests.

From the data in Table 2, The amount of most compounds was not significantly different between the untreated coffee grounds fermented water and the coffee grounds fermented water treated with pulsed electric field ($p > 0.05$). The use of pulsed electric field to treat coffee grounds before

fermentation resulted in a decrease in the amount of organic matter, organic carbon and total nitrogen by 14-17%. The untreated coffee grounds fermented water contained more organic matter, phosphorus, calcium, iron and zinc than the coffee grounds fermented water treated with pulsed electric field. The amount of potassium, magnesium, manganese and sulfur in the coffee grounds fermented water treated with pulsed electric field was higher than the untreated coffee grounds fermented water. The treatment with pulsed electric field resulted in changes in the amount of some compounds in the coffee grounds, especially the decrease in organic matter and the increase in some minerals.

Conclusion

Study of the characteristics of untreated coffee grounds fermented water compared to coffee grounds fermented water treated with pulsed electric field technology

In this experiment, coffee grounds were treated with 6kV/cm pulsed electric field technique at 1 Hz frequency for 300 pulses and then fermented with water at a ratio of 1:10 for 10 days. The results showed that the treated fermented water had a higher pH than the untreated fermented water (5.8 and 5.5), indicating that the microbial growth in the treated fermented water was lower because the pH of the microorganisms affected the composition of the food medium and the nature of the microbial surface due to atomization and acid-base cleavage. The effect on the cell surface cleavage resulted in changes in the surface properties of the biomass.

Chemical composition analysis revealed that untreated coffee grounds fermented water contained higher amounts of organic matter, organic carbon, total nitrogen, phosphorus, calcium, iron and zinc than the fermented water treated with pulsed electric field. Conversely, the treated fermented water contained higher amounts of potassium, magnesium, manganese and sulfur. The treatment with pulsed electric field reduced the amounts of organic matter, organic carbon and total nitrogen by approximately 14-17%.

References

Cervera-Mata, A., Navarro-Alarcón, M., Delgado, G., Pastoriza, S., Montilla-Gómez, J., Llopis, J., Sánchez-González, C., & Rufián-Henares, J. Á. (2019). Spent coffee grounds improve the nutritional value in elements of lettuce (Lactuca sativa L.) and are an ecological alternative to inorganic fertilizers. *Food Chemistry*, *282*, 1-8.

Cervera-Mata, A., Delgado, G., Fernández-Arteaga, A., Fornasier, F., & Mondini, C. (2022). Spent coffee grounds by-products and their influence on soil C–N dynamics. *Journal of Environmental Management*, *302*, 114075.

Chamaiporn Daengtui, Suntareekorn Ochalet, and Wasan Manoruang. (2017). Effects of bio-fermented water from coffee bean pulp and peel on the growth of Chinese cabbage. Rajabhat Phranakhon Research Journal, Science and Technology, 12(2), 54-63.

Febrian, P. A., & Masjud, Y. I. (2022). The study of composting from spent coffee grounds in making process liquid fertilizer. *Journal of Environmental Engineering and Waste Management*, *7*(2), 107-124.

Kamboj, A., Chopra, R., Singh, R., Saxena, V., & GV, P. K. (2022). Effect of pulsed electric field parameters on the alkaline extraction of valuable compounds from perilla seed meal and optimization by central composite design approach. *Applied Food Research*, *2*(2), 100240.

Matanaporn Maikami. (2021). The effect of soil mixed with coffee grounds on the germination and growth of Chinese water spinach seedlings. Journal of Science and Science Education, 4(2), 155-163.

Saberian, M., Li, J., Donnoli, A., Bonderenko, E., Oliva, P., Gill, B., Lockrey, S., & Siddique, R. (2021). Recycling of spent coffee grounds in construction materials: A review. *Journal of Cleaner Production*, *289*, 125837.