Journal of Agricultural Sciences
E-ISSN : xxxx-xxxx
P-ISSN : xxxx-xxxx

Test the Effectiveness of Eco-Enzyme Bioremediation as a Reducing Agent for Natural Stone Waste on Rice Plant Productivity and Water Quality in Dukupuntang District

R. Eviyati[1], Zakiyah Amini[2*], Siti Wahana[3]
[1]Universitas Swadaya Gunung Jati, Cirebon, Jawa Barat, Indonesia, email: *eviyatiaffandie3@gmail.com*
[2]Universitas Swadaya Gunung Jati, Cirebon, Jawa Barat, Indonesia, email: *zakiyahamini25@gmail.com*
[3]Universitas Swadaya Gunung Jati, Cirebon, Jawa Barat, Indonesia, email: *sitiwa6@gmail.com*

Abstract. Water is a natural resource that is needed for all living things. Likewise with the river used for irrigation of agricultural land. The Cigayem River is located in Dukupuntang District, Cirebon Regency. Above the river there are many natural stone cottage industries. The processing of natural stone into decorative stone requires a lot of water for its processing, so that a lot of river water in this area is polluted from this home industry activity. The waste is in the form of powder cut from natural stone with water which is directly channeled into irrigation canals without being processed first. The effect is siltation of irrigation canals and decreased water quality. This decrease in water quality has an impact on rice productivity in heavily affected areas. Pollution that occurs in irrigation canals in the study area can be identified by physical changes such as color and other impacts such as decreased productivity of rice yields in the study area since the establishment of the natural stone industry. The decline in rice productivity will threaten the sustainability of rice farming in central areas. Wastewater treatment technology has been developed a lot, but not all home industries can carry out waste treatment at a high cost. Eco enzyme can be a solution to waste pollution that pollutes rivers at a relatively low cost, easy to obtain and sustainable because all materials do not contain harmful chemicals and residues.

Keywords: River water, natural stone, eco enzyme, irrigation, waste

INTRODUCTION

According to data on rice harvest, production, and productivity by province, West Java Province is the third largest contributor to Indonesia's rice harvest area (Central Statistics Agency, 2021). Cirebon Regency, as one of the regencies in West Java, has a contribution of 4.8% to the area of harvest, production, and productivity of rice according to districts in West Java Province or the number nine most significant out of 27 of the districts/cities in West Java (BPS, 2018). So, Cirebon Regency is one of the buffers of rice production at the national level.

The natural stone industry is one of the leading commodities in Cirebon Regency (Dinas Persandian, 2020). The natural stone industry is located in four districts: Dukupuntang, Gempol, Palimanan, and Depok. The four sub-districts have a harvest area of 9,513 Ha or contribute to

10.4% of rice production in Cirebon Regency (BPS, 2021). Dukupuntang District is the fifth most significant contributor to rice production in Cirebon Regency (BPS, 2021). Cirebon has perennial land that should not be converted because it will affect agricultural production (Prasetya, 2020).

Based on Table 2, the majority of the natural stone industry is in Dukupuntang District, with as many as 273 business units or 79.4% of the total business units in Cirebon Regency and Depok District is number two, Palimanan District is third, and Gempol District is last.

Table 1. List of Natural Stone Industry Centers of Cirebon Regency in 2012

Subdistrict	Business Unit	% Business Unit	Workforce	% Workforce
Depok	63	18,3	569	28,3
Dukupuntang	273	79,4	1014	50,4
Gempol	9	2,1	39	1,9
Palimanan	35	12,0	388	19,3
Sum	**344**		**2010**	

Source: Data processed, Desperindag Kabupaten Cirebon

According to Desperindag Kab Cirebon (Table 2), there are nine leading commodities in the Cirebon region, namely meubeul/rattan handicrafts, wooden furniture, emping melinjo, bread and snacks, natural stones, rubber sandals, batik, convection and seashell crafts. Natural stone has a production capacity of 5,170,777,- m2, with the fourth largest production value of the nine leading commodities in Cirebon Regency. The natural stone industry has made a considerable contribution to the economy of Cirebon Regency.

Table 2. Number of Industries, Labor, Investment Value
According to the Type of Leading Commodities in Cirebon Regency (2019)

Featured Commodities	Sum Industry (Unit)	Labor (People)	Production Capacity	Production Value (Rp)
Rattan Crafts	1.478	62.575	184.612 ton	2.247.718.306
Wooden Furniture	1.384	11.481	1.754.242 Pcs	387.298.909
Emping Melinjo	166	1,374	1,154 ton	23.122.114
Bread	878	11.975	215.169 ton	370.385.541
Natural stone	347	2,072	5.170.777 m^2	182.813.030
Rubber Sandals	23	315	50.561 Kodi	4.455.850
Batik	594	4.629	42.033 Kodi	83.897.693
Convection	669	13.411	10.384.184 Pcs	24.213.997
Shell Crafts	8	780	332.000 Pcs	12.855.000

Source: Statistics & Coding, Cirebon Regency Communication & Informatics Office (2020)

Besides being able to drive the economy in Cirebon Regency, the natural stone industry also has a negative impact, especially on the environment. The impact is mainly due to waste produced by natural stone, both solid waste and liquid waste. Natural stone waste comes from powder produced during the natural stone-cutting (Santika et al., 2021). Waste produced by the natural stone industry only goes through processing after flowing into irrigation canals. The powder settles and is not decomposed by nature. According to (Nuraeni et al., 2014), many natural stone entrepreneurs still need WWTP.

This has an impact on water quality in natural stone industrial areas, namely in the form of an increase in pH and an increase in RSC value by 2.65 meq / l, which exceeds the maximum limit of 2.50 meq / l and affects rice production in heavily affected areas, namely a decrease in rice productivity by 1.79 (tons/ha GKG) or 25.57% (Uktiani, 2016). Natural stone entrepreneurs are reluctant to implement WWTP due to cost constraints (Nuraeni et al., 2014). The decline in rice productivity is undoubtedly worrying, mainly because the center of the natural stone industry is around rice-productive land. The decline in rice productivity will threaten the sustainability of rice farming in central areas. Therefore, a solution is needed to solve the problem.

METHOD

This research was conducted by taking samples of water polluted with natural stone waste at several sample points and testing them in the laboratory to check the level of water pollution. *The study was conducted in February 2021. The ingredients used are* Azollamicrophylla, em4, brown sugar, water, and bottles. The tools measure cups, buckets, rulers, stationery, and digital scales. The stages of research implementation are as follows: Manufacture of Azolla POC. Mix Azolla, brown sugar, water, and EM 1 tablespoon. All ingredients are mixed and put into a bottle, then close tightly. Let stand for a week until the aroma is like the aroma of tape, and then the POC can be harvested. Every day, it is always opened to release fermentation gas.

DISCUSSION

Eco-enzymes are fermentation solutions from organic waste, sugar, and water with a ratio of 3:1:10 (Larasati et al., 2020). Eco-enzymes can clean fluids, disinfectants, and insecticides. According to (Demak, 2021), eco-enzymes for agriculture have benefits as water filters, natural fertilizers for plants, herbicides, and natural pesticides. According to

(Imelda et al., 2021), eco-enzymes with a concentration of 12.5% are good at inhibiting or killing the growth of microorganisms as well as material and cost-efficient.

According to (Sayali et al., 2019), using eco-enzymes for domestic waste can reduce TDS, BOD, and COD levels. This study's results align with research results (Wikaningrum & El Dabo, 2022), that eco-enzymes can reduce ammonia levels in water, and ammonia concentrations decrease with increasing eco-enzyme concentrations with 97% linearity. Providing eco-enzymes can be a solution in dealing with contaminated water waste. Soil and water are biotic components easily contaminated with heavy metal waste.

Soil and water conditions indicated by heavy metals can affect the life chain of the biota that lives in it. Heavy metals naturally cannot be degraded in soil or water, so they will continue to increase over time (Kannan et al., 2011). *Bioremediation* is a biological remediation technique that utilizes the help of microorganisms to reduce the toxicity level in the soil. Microorganisms produce enzymes that will break down toxic pollutants and convert them into non-complex chemical structures, eventually becoming pollutants with low toxicity levels.

The effectiveness of bioremediation depends on the role of microorganisms that can adapt to the environment to accelerate the rate of decomposition of pollutants (Arbabi et al., 2009). Bioremediation techniques can be applied in the environment without causing further impacts and can reduce waste permanently (Retno & Mulyana, 2013). According to Droste & Gehr (2018), one of the safe and environmentally sound wastewater treatment technologies is using decomposed bacteria. This processing technology costs less than using chemical or physical substances.

The enzyme content in eco-enzyme products will help the bioaugmentation mechanism break down and break down harmful pollutant compounds, such as heavy metals, into harmless compounds in the environment. Eco-enzymes can treat activated sludge as a nutrient enhancer of microorganisms. Activated sludge experiments that eco-enzyme added will be biocatalytic, containing protease enzymes, lipase, and amylase. These enzymes can be applied to bioremediation techniques to change the effectiveness of harmful pollutants, such as heavy metals, in the soil (Widyasari & Wiratama, 2021).

Biological Oxygen Demand (BOD) is the quantity of dissolved oxygen needed to decompose organic matter contained in water, ideally using measures of biological and chemical processes that occur in water (Daroini & Arisandi, 2020). Water pollution impacts declining economic and social activities due to the large amount of organic matter that exceeds quality

standards or toxic substances in waters (Thambavani & Sabitha, 2012). The natural stone industry is one of the leading commodities in moving the wheels of the economy in Cirebon Regency.

The natural stone industry center area is located in four districts, namely Dukupuntang, Gempol, Palimanan, and Depok. The central area is around rice-productive land, which contributes 10.4% to rice production in Cirebon Regency. In addition to being able to drive the economy, the natural stone industry has an impact or environmental implications on the surrounding area. That is waste from natural stone production. The waste is powder from cutting natural stone, with water directly flowing into irrigation canals without being processed first.

The effect is the silting of irrigation canals and decreased water quality. This decline in water quality impacts rice productivity in heavily affected areas. Eco-enzymes, based on the results of previous research, have proven to be a solution in dealing with water waste. Therefore, the author conducted a study to determine the effectiveness test of eco-enzyme bioremediation as a reducing agent for natural stone waste on rice plant productivity and water quality in Dukupuntang District.

Table 3. Natural Stone Wastewater and Ecoenzyme Test Results

Parameter	Unit	Quality Standards	Test Result		Methods) Part Number
			Natural Stone Wastewater	Natural Stone Wastewater 1 Liter and Ecoenzyme 10 L	
Total Dissolve Solid (TDS)	mg/L	500	195	442	2540 C
Total Suspended Solid (TSS)	mg/L	400	815	817	2540 D
Color	mg/L		753	701	2120 C
Ph (At Lab)	-	6-9	8,50	7,41	4500 -H^+-B
BOD 5 days 20^0C	mg/L	150	1,74	191	APHA 5210 B
COD by $K_2Cr_2O_7$	mg/L	300	5,8	636	PO/CBN-LAB AIR/22
Dissolve Oxygen, (DO) (at lab)	mg/L	0	6,6	3,1	4500-O-B

*) Standard methods, 23rd Edition 2017, APHA-AWWA- WEF by Sucofindo, 2022
*) Exclude the scope of accreditation
Government Regulation Number 82 of 2001 concerning Water Quality and Water Pollution Control. Minister of Environment No. 5 of 2014 concerning wastewater quality standards for businesses and/or activities that do not yet have established wastewater quality standards (Uktiani, 2016).

The natural stone factory industry in Dukupuntang District has existed since 2007. This andesite natural stone business has gradually experienced significant development. In addition to the Dukupuntang District, natural stone industries in Cirebon Regency are found in the Depok, Gempol, and Palimanan Districts. The growing number of natural

stone artisans in the Dukupuntang, Depok, Gempol, and Palimanan Districts of Cirebon Regency impacts the agricultural and fisheries sectors. DLH data (2021), as many as 71 percent of natural stone artisans have yet to implement wastewater management plants (WWTP) independently, so they dispose of their waste directly in rivers.

This situation has a direct impact on the agricultural sector. Wastewater enters the irrigation network and irrigates rice fields, causing agricultural soil conditions to become harsh and brutal due to natural stone waste deposits. Based on Table 3, the results of wastewater testing that has been given eco-enzymes show that giving ecoenzymes with a 1:10 natural stone wastewater ratio can reduce pH levels to neutral (pH 7.41). According to Uktiani (2016), a pH above 8.40 can poison rice plants even though, based on the 2021 PP, it is still included in the quality standard standards.

The *Total dissolved solids* (TDS) parameter in natural stone wastewater and wastewater plus eco-enzymes is still below 500 mg / l, which is still under quality standards. However, based on Table 3, it can be seen that giving eco-enzymes can increase TDS levels from 195 mg / l to 442 mg / l. Increased TDS in water can increase awareness of water. Inorganic materials cause high TDS content through ions commonly found in water. These ions are solid particles from the natural stone processing process in the natural stone industry.

The TDS content is high, hurting the environment because TDS water absorption will slowly cover the pores of the soil so that it will reduce the penetration of sunlight into the water, inhibit oxygen exchange in water, and inhibit photosynthesis of creatures in the water. This follows the Dissolved Oxygen (DO) results in Table 3, which shows a decrease in the value of DO wastewater added to coenzymes compared to natural stone wastewater. Based on Table 3, both wastewater and wastewater that have been given eco-enzymes have Total Suspension Solid (TSS) levels above quality standards.

TSS is solid in the form of mud, clay, metal oxides, sulfides, algae, and bacteria. Natural stone wastewater results in *sludge* or mud containing dust particles from the stone-cutting process. These particles have cement-like properties (DLH, 2021). High TSS limits light penetration and water visibility. This high TSS causes the color of natural stone wastewater to be cloudy and gray. Based on Table 3, eco enzymes do not impact TSS in natural stone wastewater. Table 3 shows that eco enzymes can increase BOD and COD in water.

This is following the results of research by Sayali et al. (2019); increasing the presentation of eco enzyme concentrations can increase BOD and COD in water. Based on the analysis of BOD results in Table 3, the BOD value of natural stone wastewater coupled with eco-enzymes has increased compared to natural stone wastewater without coenzymes. Coenzyme materials influence this in the form of organic matter. High organic matter content in waters impacts BOD content in waters.

Conversely, the lower the organic matter in the water, the lower the BOD. The content of BOD also has an impact on DO in water. According to Daroini Arisandi (2020), DO and BOD have an inversely proportional relationship. The higher the BOD content, the lower the DO content in water. This is also seen in Table 3. The higher BOD in natural stone wastewater plus eco-enzymes decreases the DO value when compared to the BOD and DO values of natural stone wastewater without eco-enzymes

CONCLUSION

From this study, it can be concluded that Ecoenzyme can neutralize pH in natural stone wastewater but does not impact the TDS and TSS values of natural stone waste. Ecoenzymes even increase the value of BOD and COD in water and decrease the DO value in natural stone wastewater.

BIBLIOGRAPHY

Arbabi, M., Sadeghi, M., & Anyakora, C. (2009). Phenanthrene contaminated soil biotreatment using slurry phase bioreactor. *American Journal of Environmental Sciences*, *5*(3), 223–229. https://doi.org/10.3844/ajessp.2009.223.229

Badan Pusat Statistik. (2021). Luas Panen, Produksi, dan Produktivitas Padi Menurut Provinsi 2018-2020. In *Berita Resmi Statistik*. https://www.bps.go.id/indicator/53/1498/1/luas-panen-produksi-dan-produktivitas-padi-menurut-provinsi.html

BPS. (2018). *Luas Panen, Produksi, dan Produktivitas Jagung dan Kedelai Menurut Kabupaten/Kota di Provinsi Jawa Tengah, 2015*.

BPS. (2021). *Luas Panen Padi , Produksi, Dan Produktivitas Padi Menurut Kecamatan*.

Daroini, T. A., & Arisandi, A. (2020). Analisis Bod (Biological Oxygen Demand) Di Perairan Desa Prancak Kecamatan Sepulu, Bangkalan. *Juvenil*, *1*(4), 558–567. http://doi.org/10.21107/juvenil.v1i4.9037ABSTRAK

Demak, D. (2021). *Dashyatnya Manfaat Eco-enzym untuk Pertanian*.

DLH, K. C. (2021). *Kajian Sebaran Limbah Industri Batu Alam*.

Imelda, D., Alif, A., & Satriawan, B. (2021). *Pembuatan Produk Multipurpose Cleaning dengan Pemanfaatan Eco-enzym dari Limbah Kulit Buah Sebagai Bahan Aktif Natural Antimikroba*.

Kannan, R., Ganesan, M., Govindasamy, C., Rajendran, K., Sampathkumar, P., & Kannan, L. (2011). Tissue concentration of heavy metals in seagrasses of the Palk Bay, Bay of Bengal. *International Journal of Ecology & Environmental Sciences*, *18*(1), 29–34. https://doi.org/10.6088/ijes.00202010016

Larasati, D., Astuti, A., & Maharani, E. (2020). Uji Organoleptik Produk Eco-Enzyme dari Limbah Kulit Buah. *Seminas Nasional Edusaintek*, 278–283.

Nuraeni, N., Hidayat, M., & S, W. (2014). Pengawasan Pengelolaan Limbah Industri Batu Alam oleh Badan Lingkungan Hidup Daerah Kabupaten Cirebon (Studi Kasus di Kecamatan Dukupuntang). *Publika*, *2*(2), 84–99.

Persandian &, B. S. D. K. & I. K. C. (2020). *Statistik Daerah Kegiatan Pengolahan, Updating dan Analisis Data dan Statistik Daeraf*.

Prasetya, A. (2020). Dinas Pertanian Cirebon Siap Tolak Izin Alih Fungsi Lahan Pertanian. *Kompas*.

Retno, T., & Mulyana, N. (2013). Bioremediasi Lahan Tercemar Limbah Lumpur Minyak Menggunakan Campuran Bulking Agents yang Diperkaya Konsorsia Mikroba Berbasis Kompos Iradiasi Bioremediation of Oil Sludge Contaminated Soil Using Bulking Agent Mixture Enriched Consortia of Microbial Inocu. *Jurnal Ilmiah Aplikasi Isotop Dan Radiasi*, *9*(2), 139–150.

Santika, S., Asdak, C., & Suryadi, E. (2021). Jurnal Indonesia Sosial Sains. *Jurnal Indonesia Sosial Sains*, *1*(10), 132–141.

Sayali, J. D., Shruti, S. C., Shweta, S. S., Sudarshan, P. E., Akash, D. H., Shrikant, P. T., & Students, D. (2019). Use of Eco Enzymes in Domestic Waste Water Treatment. *International Journal of Innovative Science and Research Technology*, *4*(2), 568–570. www.ijisrt.com568

Thambavani, D. S., & Sabitha, M. (2012). Multivariate statistical analysis. *Scholarly Journal of Mathematics and Computer Science*, *1*(1), 1–7. https://doi.org/10.1142/6744

Uktiani, A. (2016). Dampak Pembuangan Limbah Industri Batu Alam Terhadap Kualitas Air Irigasi Di Kecamatan Palimanan Kabupaten Cirebon. *Jurnal Geografi*, *13*(1), 62–70. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjbxJj368rxAhV_ILcAHYuQAvAQFjAAegQIBBAD&url=http%3A%2F%2Fperpustakaan.pertanian.go.id%2Frepository_litbang%2Fuploaded_files%2FBalit_Lahan_Rawa%2Fdampak_pengaruh_limbah

Widyasari, N. L., & Wiratama, I. G. N. M. (2021). Studi Teknik Bioremediasi Tanah Tercemar Logam Berat dengan Menggunakan Eco-Enzyme. *Jurnal Ecocentrism*, *1*(2), 88–95.

Wikaningrum, T., & El Dabo, M. (2022). Eco-Enzyme Sebagai Rekayasa Teknologi Berkelanjutan Dalam Pengolahan Air Limbah. *Jurnal Penelitian Dan Karya Ilmiah Lembaga Penelitian Universitas Trisakti*, *7*(1), 53–64. https://doi.org/10.25105/pdk.v7i1.10738