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EFFECT OF ECO ENZYME ADDITION ON THE IMPROVEMENT OF WATER QUALITY, REDUCTION OF AMMONIA AND METAL IN DUG WELL WATER

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ABSTRACT

This study aims to: (1) Analyze the effect of artificial eco enzyme addition on improving the quality of dug well water based on pH, TDS, TSS, and DO parameters; (2) Analyze the effect of artificial eco enzyme addition on reducing ammonia and metal content in dug well water. The type of research is a laboratory-scale experiment with a quantitative approach to dug well water samples treated using a complete randomized design (CRD). The characteristics of the experimental test are 4 times treatment 1 time repetition in a homogeneous sample population. The conclusion of the research is that the provision of artificial eco enzyme has an effect in the form of an average increase and decrease in each parameter of the water quality of the dug well, namely pH 0,4, TDS 22 mg/l, TSS 13,3 mg/l, DO 4,2 mg/l, NH3 2,5 mg/l, Fe 0,4 mg/l, and Mn 0,03 mg/l. Based on one-way ANOVA testing resulted in sig. 0.001 < 0.05 and Duncan testing resulted in different number notations in each sample with sig. 1.000 > 0.05 which means the addition of eco enzyme gives a real influence on improving the quality of well water.

Keywords: Eco enzyme; dug well water; pH, TDS, TSS, DO; ammonia, iron, & manganese

INTRODUCTION

Water is an important element that is always used every day, so it is impossible to be separated from human life. Water is a universal solvent therefore water is very easily polluted by environmental conditions. (Armadi et al., 2019). Parameters of water quality can be used to identify the feasibility of water sources and provide important information about the quality conditions of water bodies, including the level of pollution and its potential effect on the surrounding environment and human health (Bartram & Ballance, 2020).

Around 22.6 million households or 87.7 million people still rely on well water as a source. Meanwhile, in 2019 alone, for South Kalimantan Province, the percentage of households that had access to decent and sustainable drinking water source services was 60.57% (Indonesian Central Bureau of Statistics, 2018). Protected dug wells are used by 21%, while pump wells and tap water are used by 15.4% and 10.7% of the total population in Indonesia (Indonesian Central Bureau of Statistics, 2020). People in urban areas who use water sources from pump wells and piped wells are 32.9% and 28.6%, respectively. Meanwhile, protected dug wells are more commonly used by people in rural areas as much as 32.7% of the total population of Indonesia by region (Ministry of Health, 2013).

Several studies have found that dug wells in Indonesia that are used as daily water sources still exceed the predetermined standardization threshold. The study is based on chemical physical examination and

bacteriological examination (Rohmatika & Hariyanto, 2019; Wolo et al., 2020). Based on another study, comparing water quality from dug wells with borehole/pump water in Malawi, it was found that dug well water had worse water quality than pump water (Matsimbe, 2020).

The analysis of previous studies mentioned that the parameters of iron, manganese, chloride, and turbidity found in excavated well water The Decree of the Indonesian Minister of Health No. 907/ MENKES/SK/VII/2002 on Water Quality Requirements for Sanitary Purposes, regulates several water quality parameters that must be met for sanitary purposes, such as color, odor, taste, pH, TDS (Total Dissolved Solids), and heavy metal content. This decree specifies the water quality standards that must be met for each of the parameters. (AJ Mohamed & M Kitwana, 2018).

Table 1. Parameters in the Environmental Health Quality Standard for Water Media for Sanitary Hygiene Purposes

No.	Parameters	Unit	Maximum
1	pH	mg/l	6,8 – 8,5
2	TDS	mg/l	1000
3	Iron	mg/l	1
4	Manganese	mg/l	0,5
5	Turbidity	NTU	25
6	Color	TCU	50
8	Taste		Flavorless
9	Odor		Odorless

Ministry of Health Regulation RI No.32/2017

Table 2. Parameters in the Standard for Domestic Wastewater Quality Standard Standalone

No.	Parameters	Unit	Maximum
1	pH		6 – 9
2	BOD	mg/l	30
3	COD	mg/l	100
4	TSS	mg/l	30
5	Ammonia	mg/l	10

Minister of Environment and Population of the Republic of Indonesia No.P.68/2016

Water quality parameters such as pH, TDS, TSS, and DO provide useful data in evaluating water conditions. Therefore, actions are needed to keep water quality suitable and safe for humans (Bartram & Ballance, 2020). Indications of ammonia and metal levels determine the suitability of water for use. High levels of ammonia in water can cause health problems for humans and animals. In addition, metal levels in water also need to be monitored because they can come from natural sources as well as human activities such as mining, industry, and waste disposal (Sadiq et al., 2021).

Most residents of Muara Awang Parupuk in Guntung Ujung Village, Gambut Sub-district, still use dug wells as their daily water source for sanitation. There is a need for renewal of dug well water quality management by applying components and materials that are practical and inexpensive. According to Nazim and Meera (2017), an environmentally friendly solution is the processing of household waste from each house to be made into eco enzyme products that can improve water quality.

METHODS

The type of research is a laboratory-scale experiment with quantitative approach to dug well water samples that are treated using a complete randomized design (CRD). Measurements were carried out in 2 types of stages, namely measurement by direct method to measure pH, TDS, DO, and spectrophotometric method to measure TSS, ammonia and metal content. The experimental test was characterized by 4 treatments with 1 repetition on a population of homogeneous samples that had been incubated 1 x 24 hours with eco enzyme liquid. The research was conducted with a

duration of 4 weeks and the data obtained were analyzed using analysis of variance. The test of the effect of eco enzyme on the results of the dependent variable was carried out at the Water Quality and Hydro-Bioecology Laboratory of the Faculty of Fisheries and Marine Sciences.

Eco Enzyme Preparation

Table 3. Comparison of Eco Enzyme Ingredients

Sample Preparation

Material	Water	Aren Sugar	Vegetables & Fruits
Comparison	10	1	3
Volume	12000 ml	1200 gram	3600 gram

The number of test samples made is four, each of which contains 1 liter of well water sample and the addition of eco enzyme with different concentrations. Repetition was done once on each test sample with a tight container and incubation time was 1 x 24 hours. Eco enzyme must be completely dissolved in water before data collection in the laboratory. Sampling of well water using purposive sampling method (Mangalik, 2022).

P_0 : 1 liter of well water + 0,0% EE.
: 1 liter of well water (purified)
P_1 : 1 liter of dug well water + 0,2% EE.
: 1 liter well water + 2 ml eco enzyme
P_2 : 1 liter of dug well water + 0,4% EE.
: 1 liter well water + 4 ml eco enzyme
P_3 : 1 liter of dug well water + 0,6% EE.
: 1 liter well water + 6 ml eco enzyme
*EE. = eco enzyme

Data Collection

Four test samples made by adding different concentrations of eco enzyme were measured for pH, TDS, TSS, DO (dissolved oxygen), ammonia, iron, and manganese. There are 2 types of measurements, namely direct method for pH, TDS, DO, and spectrophotometric method to measure TSS, ammonia, (NH_3), iron (Fe) and manganese (Mn).

With the following research hypothesis:

H0 : Eco enzyme has no effect on water quality, ammonia and metal levels in excavated well water.
H1 : Eco enzyme influences the water quality, ammonia and metal levels in the excavated well water.

Data Analysis

Data analysis was carried out quantitatively, by comparing measurement data from the four samples using the analysis of variance (Anova) method. This analysis can determine the existence of differences produced between treatments in terms of the parameters observed. The analysis will show a real effect with a sig value <0.05 where: (1) $P < 0.05$ significant effect (H1 accepted, H0 rejected); (2) $P \geq 0.05$ has no real effect (H1 rejected, H0 accepted) (Kadir, 2015). Average decrease and increase due to treatment, calculation basis:

Decrease = baseline measurement – treatment measurement ..... (1)
Increase = measurement treatment – baseline measurement ..... (2)
Average = $\frac{P1+P2+P3}{3}$ ..... (3)

RESULTS AND DISCUSSION

RESEARCH RESULT

Observation of Dug Well Water

Table 4. Well Water Observation Results

No	Parameters	Result Observation
1	pH	The pH measurement resulted 6.04
2	Turbidity	Turbidity is dense and there is silt
3	Color	Brownish color (dominant light brown)
4	Taste	Has a slightly astringent taste dominant acid
No	**Parameters**	**Result Observation**

5	Odor	Has a sludge odor and smells slightly like rusty iron
6	Texture	Leaves a slight mud stain when handled
7	Environmental Conditions	The dug well is in a resident's yard right next to the highway, potential contamination comes from household waste, runoff of yard soil and roads

Fermentation

The eco enzyme fermentation was carried out for 90 days and macroscopically there were changes in color, texture, volume, and aroma. The changes were observed upon opening and stirring the eco enzyme on the 1st, 7th, 30th days and upon harvesting on the 90th day. According to Galintin et al. (2021), during the first month of the fermentation process, the gas formed must be released, so the researcher opened and stirred to avoid the rupture of the container due to excess pressure during burial.

Table 5. Observations on The Fermentation Process

Time	Color	Scent	Picture
Day-1	Clear Brown	Fruity scent	
Day-7	Brown Turbid	Sweet and sour	
Day-30	Brown Turbid	Fresh sour	
Day 90	Clear Brown	Strong sour (honey-like scent)	

Measurement of Water Quality

There were 4 samples, namely P0 = 0.0% eco enzyme as pure well water, P1 = 0.2% eco enzyme, P2 = 0.4% eco enzyme, and P3 = 0.6% eco enzyme. Overall, the measurement results show a decrease in parameters, which means there is an influence due to the addition of different doses of eco enzyme.

Table 6. Measurement Results of Physical Variables of Water Quality

Code	pH	TDS	TSS	Turbidity
P_0	6,04	192 mg/l	53 mg/l	72 NTU
P_1	5,82	200 mg/l	44 mg/l	49,94 NTU
P_2	5,71	214 mg/l	40 mg/l	47,60 NTU
P_3	5,49	227 mg/l	35 mg/l	43,31 NTU

Table 7. Measurement Results of Chemical Variables of Water Quality

Code	DO	NH_3	Fe	Mn
P_0	7,4 mg/l	4,4 mg/l	5,92 mg/l	0,084 mg/l
P_1	3,4 mg/l	2,6 mg/l	5,6 mg/l	0,069 mg/l
P_2	3,2 mg/l	2,3 mg/l	5,48 mg/l	0,06 mg/l
P_3	3,0 mg/l	0,8 mg/l	5,48 mg/l	0,037 mg/l

DISCUSSION

Characteristics of Eco Enzyme

Eco enzyme that has gone through a fermentation process for 90 days has a clear brown color, has a strong fresh sour aroma and a slight honey-like aroma and the pH measurement of eco enzyme is 3.2. The pH measurement results are in line with previous research which states that eco enzyme liquid products from organic waste produce acidic chemical parameters (Larasari et al., 2020). This is in accordance with the results of the fermentation that has been carried out, the eco enzyme product has changed from cloudy brown from the color of the palm

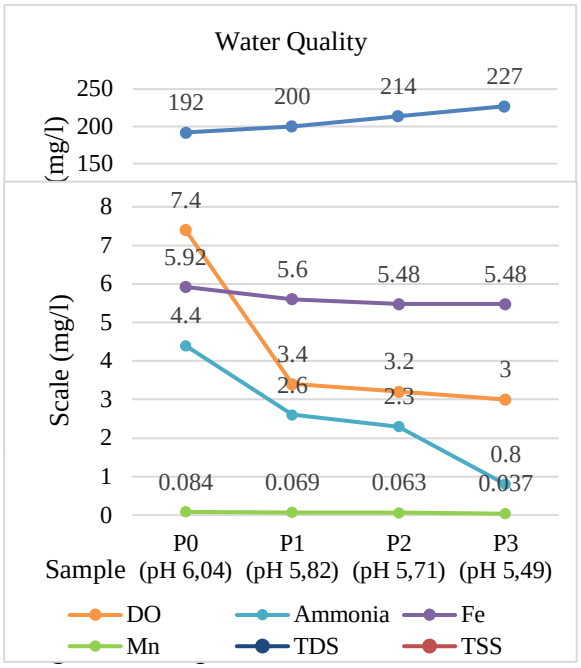
sugar solution to a clear brown color produces pH no more than 4.

Organic acid is an important key in determining the acidity of a product. Thus, the low pH value of eco enzyme in this study was due to the presence of high organic acid in the form of acetic acid (Etienne, 2013). Acetic acid is the result of natural bacterial metabolism found in the fruits and vegetables used. Anaerobic metabolic process or fermentation process is the activity of bacteria to produce energy from carbohydrates in anaerobic or oxygenless conditions that produce by-products in the form of acetic acid or alcohol (Larasari et al., 2020).

The fermentation that occurred in this experiment dominantly produced acetic acid instead of alcohol compounds, because most types of bacteria produce pure acetic acid compared to the formation of alcohol. Fermentation that produces acetic acid and alcohol with disinfectant properties is formed from the carbohydrate (sugar) content of the ingredients used (Eviati & Sulaeman, 2009). In another study, it was mentioned that there was an effect of using molasses and palm sugar during the fermentation process. The pH parameter value is lower when using molasses sugar compared to brown sugar (Arun, 2015).

The results of the experiment conducted are in accordance with research by Vama & Cherekar (2020), who also mentioned that the characteristics of eco enzyme products fermented for 90 days should be environmentally friendly which goes through several stages of fermentation, namely decomposition, transformation, and recombination of the materials used. In this experiment, the decomposition and recombination of citrus fruit, pineapple, and vegetable waste materials together with water and palm sugar to form a complex solution that has cleaning and anti-microbial properties.

Water Quality



Referring to the Regulation of the Indonesian Minister of Health No. 32 of 2017 and the Regulation of the Minister of Environment and Population No. P.68 of 2016, the results of well water quality measurements show that some parameters are above the maximum levels. TSS, turbidity, and iron parameters are still outside the predetermined threshold, but the provision of eco enzyme products can reduce the presence of these parameter levels (Mugitsah, 2021).

Table 8. Average Decrease and Increase Due to Treatment

No	Parameters	Effect	Average
1	pH	Decreased	0,4
2	TDS	Increased	22 mg/l
3	TSS	Decreased	13,3 mg/l
4	DO	Decreased	4,2 mg/l
5	Ammonia	Decreased	2,5 mg/l
6	Iron	Decreased	0,4 mg/l
7	Manganese	Decreased	0,03 mg/l

Measurement of the water quality parameters of the dug wells resulted in a difference in the average decrease in each parameter. The average calculation is obtained from the difference between the initial measurement of each parameter and the measurement results during the eco enzyme addition treatment. The results are pH, TSS, DO, ammonia, iron metal, and manganese parameters have decreased while the TDS itself has increased. According to Sondang et al. (2023), the effect of parameters contained in water after being given eco enzyme can vary depending on various innate factors, including the type of eco enzyme used, the application of eco enzyme dosage, metal characteristics, and environmental.

pH

The decrease in well water pH is due to the influence of the acidic pH of the eco enzyme, which is 3.2. The formation of organic acids has produced acetic acid microorganisms, which occur fermentation in sugar solutions with organic acids as by-products (Larasari et al., 2020). This organic acid then affects the pH of the well water by lowering it. This means that in the experiments that have been conducted, the eco enzyme produces a significant enough amount of organic acid to cause a decrease in water pH from 5.82 to 5.49.

According to Janarthanan et al. (2020), the use of fruit and vegetable waste types of results in reducing water contamination so that it can reduce pH. The addition of this eco enzyme can create stability to the desired water pH control. In this experiment, the types of fruit are dominated by pineapple and orange while vegetables are dominated by mustard greens. Eco enzyme can reduce the pH value of water because of the organic acid content in the form of acetic or citric acid.

Total Dissolved Solids (TDS)

There was an increase in TDS, but macroscopically the well water decreased in turbidity. All well water samples produced different levels of clarity with sediment forming at the bottom of the bottle. In the experiments conducted, particles that have been bound to settle at the bottom of the sample bottle form a sediment that causes a decrease in the turbidity index of the sample, so that macroscopically the well water looks cleaner. However, the sediment formed resulted in an increase in TDS levels during sample measurements. The TDS measurement results are 200 mg/l to 227 mg/l, which means that when the turbidity decreases, the dissolved solids will increase due to sediment.

Total Suspended Solids (TSS)

The decrease in suspended solids is due to the degradation reaction that takes place during the addition of eco enzyme. The degradation reaction occurs due to the enzyme content in the form of protein molecules that have a natural catalyst function that can catalyze complex organic matter in water bodies into simpler substances (Rasit et al., 2019). In the experiments conducted, enzymes can convert compounds into soluble and degradable substances so that the measurement of suspended solids content produces lower numbers.

Dissolved Oxygen (DO)

According to Hertika et al. (2022), oxygen solubility can be influenced by temperature conditions. Oxygen with temperature is inversely proportional, if the temperature is high, then the solubility of oxygen is low and vice versa. Rapid oxygen diffusion occurs at the surface of the water, while the bottom layer, oxygen diffusion runs normally. According to Effendi (2003), dissolved oxygen levels fluctuate depending

on the movement (turbulence) and mixing (mixing) of water masses, respiration activity, photosynthesis, and the type of effluent in water bodies.

Puspitasari et al (2017) continued that an increase in respiration rate causes oxygen consumption to increase so that the dissolved oxygen content decreases. As for the experiments that have been carried out, the measurement of dissolved oxygen results in a decrease in each sample from 3.4 mg/l to 3 mg/l. This means that the increase in temperature in the sample bottle that has been added to the eco enzyme with acid content has reduced the dissolved oxygen content.

Ammonia (NH_3)

According to Range et al. (2012), ammonia (NH3-N) can undergo oxidation conditions into nitrite and nitrate in water which in turn can reduce its concentration in water. Whereas in the research of Bahari and Wikaningrum (2022), mentioned that the higher the addition of eco enzyme concentration, the higher the ammonia reduction produced, so that the increase eco enzyme concentration is in line with the increase in ammonia reduction. As for the experiments that have been carried out, the ammonia content has decreased from 2.6 mg/l to 0.8 mg/l. This means that eco enzyme acidic liquid has an influence on reducing ammonia content in well water.

Iron (Fe)

According to Benny et al. (2023) and Zhu et al. (2020), the use of eco enzyme products is one of the effective environmentally friendly methods in the treatment of various types of metal waste. Eco enzyme can break down and decompose the pollutant content of complex compounds by filtering, ion exchange, or chemical precipitation processes. As for the experiments that have been carried out, the measurement results of iron metal have decreased to 5.48 mg/l. Eco enzyme does not directly reduce heavy metal levels in water but helps reduce metal contamination through the decomposition process so that iron content bound to organic waste is more quickly decomposed and removed from the water structure. As a result, iron content is reduced and water quality is improved.

Manganese (Mn)

According to Benny et al. (2023) and Zhu et al. (2020), the use of eco enzyme products is one of the effective environmentally friendly methods in the treatment of various types of metal waste. Eco enzyme can break down and decompose the pollutant content of complex compounds by filtering, ion exchange, or chemical precipitation processes. As for the experiments that have been carried out, the results of manganese metal measurements have decreased to 0.037 mg/l.

Eco enzyme does not directly reduce heavy metal levels in water, but helps reduce metal contamination through the decomposition process. The addition of eco enzyme concentration helps accelerate the decomposition of organic matter so that the manganese content bound to organic waste is more quickly decomposed and removed from the water structure. As a result, the content of manganese in dug well water is reduced and water quality is improved.

Significance Results of Water Quality Parameters

Table 9. ANOVA Test Results

ANOVA					
Water Quality					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1240,322	6	206,720	7,105	,001
Within Groups	407,340	14	29,096		
Total	1647,662	20			

The average decrease and increase in each parameter are pH 0.4, TDS 22 mg/l, TSS 13.3 mg/l, DO 4.2 mg/l, NH3 2.5 mg/l, Fe 0.4 mg/l, and Mn 0.03 mg/l. The average calculation is obtained from the difference between the initial measurement of each parameter and the measurement results during treatment. The results of the analysis in Table 9. show that the statistical resulted in a sig value = 0.001, which means <0.05. This means that this value states the significance of the average difference in water quality in each parameter of the three treatments. Based on this, H0 is rejected and H1 is accepted, which means that the provision of eco enzyme in well water has a significant effect on water quality.

Table 10. Duncan Test Results

Parameters of Water Quality

Duncan[a]

Treatment	N	Subset for alpha = 0,05		
		1	2	3
P1	3	63.2500		
P2	3		208.2500	
P3	3			576.5000
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3,000.

* P = sample code

Based on Duncan's test in table 10. it is shown that the water quality of P1 well is significantly different from the water quality of P2 and P3. Then the water quality of P2 wells is significantly different from the water quality of P1 and P3. While the water quality of P3 wells is also significantly different from the water quality of P1 and P2. The results of the data have notations of numbers that are not the same and each is in a different column, so it means that each treatment given has a different effect on the quality of well water significantly.

Interpretation based on the table is that every administration of eco enzyme 0.2% in well water produces a significantly different effect with the administration of eco enzyme 0.4% and 0.6%. Then the provision of eco enzyme 0.4% in well water produced a significantly different effect with the provision of eco enzyme 0.2% and 0.6%. While the provision of eco enzyme 0.6% in well water produces an effect that is significantly different from the provision of eco enzyme 0.2% and 0.4%.

CONCLUSIONS

The conclusion of the research is the addition of eco enzyme to the dug well water gives an effect in the form of an average increase and decrease in each parameter measuring the quality of dug well water. The addition of eco enzyme liquid with pH 3.2 gives an real effect on the experiments that have been carried out, namely pH 0.4, TDS 22 mg/l, TSS 13.3 mg/l, DO 4.2 mg/l, NH3 2.5 mg/l, Fe 0.4 mg/l, and Mn 0.03 mg/l. Based on one-way ANOVA testing resulted in a significance of 0.001 <0.05 and Duncan's test with different results for each sample which means H0 is rejected and H1 is accepted. So that the addition of eco enzyme can have a real effect on improving the quality of dug well water.

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