POTENTIAL UTILIZATION OF NATURAL KAOGULAN MORINGA SEED (Moringa oleifera) ON WASTE CLEANING PROCESS Palm Oil Mill Effluent (POME)

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ABSTRACT

Palm Oil Mill Effluent (POME) is a type of waste generated from the activities of the palm oil industry. This waste has the potential of polluting the aquatic environment, most especially in the process of utilizing waste in the form of Land Application (liquid fertilizer). Thus, this study focus on the minimization of pollution risk using Moringa seed powder (Moringa oleifera) as a natural purifying agent. The doses used are 0 g/L, 1.00 g/L, 2.00 g/L, 3.00 g/L, and 4.00 g/L respectively with 3 replications. The experimental design used is a single factor RAL (Completely Randomized Design). Parameters measured are pH, TSS, BOD, and heavy metal Fe. Based on the results of the correlation test, it was observed that the effect of increasing the dose of Moringa seed powder gave a negative (very strong) correlation on all observation parameters. The optimal dose for the use of Moringa seed powder for each parameter is different. For pH, a dose of 2 g/L (with a pH of 6.19) was found, for TSS 4 g/L (TSS value of 359.67), BOD 1 g/L (BOD value 2016, 33). Meanwhile, for heavy metal Fe, the optimal dose is 1 g/L (with a Fe value of 0.93).
Keywords: **NATURAL KAOGULAN,** waste, Moringa

INTRODUCTION

Oil palm (Elaeis guineensis) is one of the main commodities amongst Indonesian crops plantation as a foreign exchange earner. The expansion of oil palm plantations in Indonesia has the potential to provide economic benefits but can result in environmental disturbances (Utami et al., 2017). On the other hand, this industry is one of the largest sources of waste in Indonesia. This is because in the process of producing CPO (Crude Palm Oil) the palm oil plantation industry always produces

liquid waste called Palm Oil Mill Effluent (POME). In general, POME has a temperature between 60^{O}C-8^{O}C, pH 3.3 to 4.6, thick, brownish in color, solids content, contains oil and fat, as well as high COD and BOD. Palm oil mills produce an average of 0.7–1 m3 of POME for each tonne of fresh fruit bunches. POME contains large amounts of Calcium, Magnesium, Nitrogen, and Potassium, so it can be used as fertilizer (Zulkifli, 2016). Due to its nutrient content, the waste can be used as a liquid fertilizer (Land application) which supports the growth of oil palm trees.

Using POME for fertilization is quite risky in the form of environmental pollution, especially groundwater. Virgianti et al. (2014) stated that land application on oil palm plantations has an influence on the quality of groundwater and surface water, where the value of BOD, TSS, NH3 and DO on the land application is greater than the value in non-land application. According to Nadia et al. (2017), the dissolved solid contents in palm oil industrial wastewater are produced from lignocellulosic palm fruit. Lignocellulose consists of lignin, hemicellulose, and cellulose. This industrial effluent when discharged directly into open ponds or water bodies such as rivers, swamps, and lakes, can produce methane gas and other gases that will cause the greenhouse effect. Several ways are worth considering to overcome the problems that exist in palm oil effluent to prevent environmental pollution. One way is to use poly aluminum chloride (PAC) as a coagulant. PAC is a coagulant commonly used in industrial waste treatment processes. This chemical compound has the potential of a coagulant to be used for various industrial wastes. PAC has various advantages, namely low corrosivity, the resulting floc is easier to separate, and the pH of the treated water is not too low (Budiman et al., 2008). Besides that, PAC also has a strong adsorption rate, adhesive strength, fast sedimentation rate, wide scope of use, and it's being used at low concentrations (Hutomo, 2015). However, PAC has several advantages, and also some disadvantages to the environment. Aluminum ions produced by the hydrolysis of PAC can interfere with human health, this causes people who drink water containing high concentrations of Al ions from PAC to suffer from anemia, hair loss, and brain dementia.

Given the risks above, it is appropriate to consider the use of organic coagulant materials that can be considered environmentally friendly. Utami (2012) stated that Moringa seeds can be used as one of the alternatives to natural coagulants available locally. The coagulation effectiveness of Moringa seeds is determined by the cationic protein content. The advantage of using natural coagulants such as Moringa seed powder is that these plants are easy to find in tropical climates.

In addition, natural coagulants can form flocs that are against friction during turbulent flow than chemical coagulants.

Based on some of the considerations above, Moringa seeds deserve to be considered as one of the organic materials that are suitable for use as natural coagulant ingredients for the purification of Palm Oil Mill Effluent (POME).

This study aims to determine the effective dose of Moringa seed powder on several solution parameters, including pH, BOD, COD, and the solubility of heavy metal Fe. These parameters are components that determine the quality of groundwater and surface water.

RESEARCH METHODS

This research was conducted at PT Sawit Niagamas Gemilang. Administratively, the company is located in Jonggon Village, Kec. Loa Kulu, Kutai Kartanegara Regency, East Kalimantan Indonesia. The extraction of Palm Oil Mill Effluent (POME) was carried out in pond 1, the company's waste treatment unit.

Data source

This study used primary data obtained from the treatment of Moringa seed powder (Moringa oleifera) with several dosage levels for Palm Oil Mill Effluent (POME). Furthermore, to determine the extent of the effect of the treatment, an analysis of the following parameters was carried out: pH, BOD, COD in the water laboratory of the Faculty of Fisheries and Marine Sciences, Mulawarman University.

Water Quality Component Test Method

The test method in this study is the Jar Test method using a Completely Randomized Experimental Design. The main ingredients used are liquid waste from the palm oil plantation industry, namely Palm Oil Mill Effluent (POME), Moringa seed powder (Moringa oleifera), and aquadest. Meanwhile, the equipment used includes glass tubes, plastic buckets, pH meters, magnetic stirrer, measuring pipettes, and measuring cups as well as water analysis tools in the laboratory.

The process of testing the jar test on the waste is carried out by inserting Palm Oil Mill Effluent (POME) into glass tubes with a volume of 1000 mL each. The next step is the addition of Moringa

seed powder (Moringa oleifera) which has been mashed and sifted with doses of 0 g, 1.00 g, 2.00 g, 3.00 g, and 4.00 g, respectively. Each treatment was repeated three times. Then the solution was stirred for 5 minutes at a speed of 40 rpm. The solution was then deposited for three hours. After that, 100 ml of the solution sample was taken for each experimental unit. The next step was analyzing the solution in the laboratory to see the pH, BOD, COD, and heavy metal Fe.

Results and Discussion

pH of solution

The test results on the pH of the Palm Oil Mill Effluent (POME) solution after being treated with Moringa seed powder can be seen in Table 1 and Figure 1:

Table 1. Effect of Different Doses of Moringa (Moringa oleifera) Seed Powder on pH POME (Palm Oil Mill Effluent)

		Test			Amount	Averarge
No.	Treatment	R1	R2	R3		
1.	Moringa Powder 0 g (P0)	6,31	6,19	6,19	18,70	6,23[a]
2.	Moringa Powder 1 g (P1)	6,16	6,19	6,24	18,59	6,20[a]
3.	Moringa Powder 2 g (P2)	6,17	6,18	6,21	18,56	6,19[ab]
4.	Moringa Powder 3 g (P3)	6,17	6,17	6,18	18,52	6,17[ab]
5.	Moringa Powder 4 g (P4)	6,12	6,14	6,12	18,38	6,13[b]

Keterangan : Numbers followed by the same letter in the same column are not significantly different in the test BNT 5%

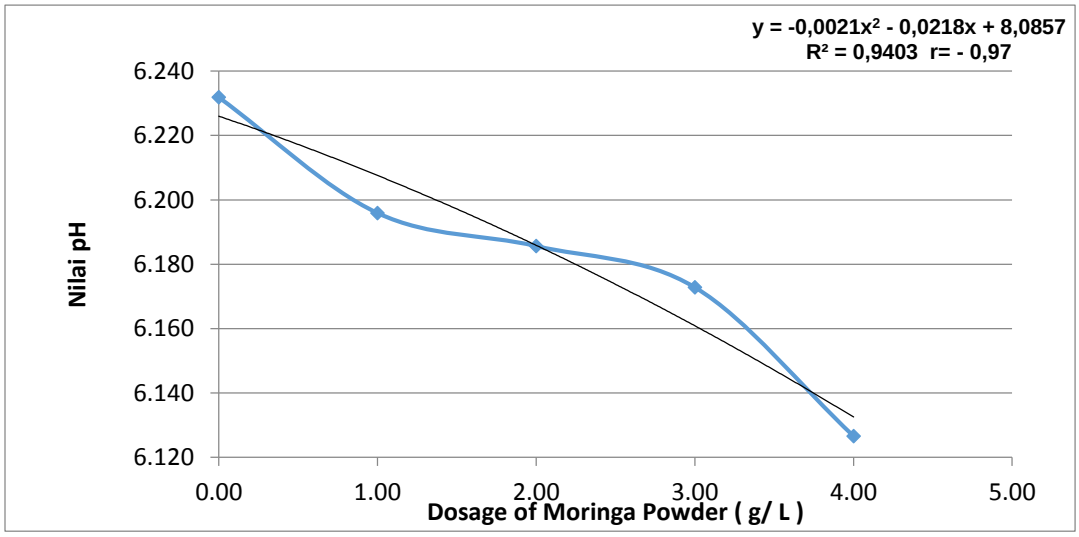

Figure 1. The Relationship Between Moringa Powder Dose Increase and Changes in pH Value of POME Solution

As seen in Table 1, the lowest pH value of the POME solution was found in treatment P4 (Corella powder 4.00 g/L) with a value of 6.13 and significantly different from treatments P0 and P1. This shows that the administration of Moringa powder at a dose of 2.00 g/L POME gave an effect that tends to be the same as the dose of 4.00 g/L. Meanwhile, the highest pH value was in the P0 treatment (without Moringa powder) with a pH value of 6.23. From the pattern of changes in the pH value in relation to the increase in the dose of Moringa seed powder, it shows that the higher the dose given, the lower the POME pH value. The relationship is classified as strong because the results of the correlation test have a value of r = -0.97 . The same was also reported by Putra et al. (2020), Moringa seed powder and long deposition time are proven to reduce the pH value of pig farm wastewater. Shan et al. (2017), had a different report, that the effect of droping Moringa seed powder in the water of the Baluk River did not have a significant effect in changing the pH value of the water.

This decrease in pH value is as a result of the Moringa seeds being included in the group of organic materials derived from plants. This material generally contains humic acid. This acid is a mixture of organic acids from aliphatic groups (long chain carbon structures) and aromatics (ring-shaped carbon structures) which are insoluble in water but soluble in alkaline conditions (Saidy, 2018). According to Roman et al. (2020) the pH conditions are relatively more acidic due to the decomposition of organic matter. This decomposition produces carbon dioxide, if it reacts with water that does not have minerals it will cause the condition to become an acidic solution.

TSS (Total Suspended Solid)

The test results on the treatment of Moringa seed powder on the TSS (Total Suspended Solid) Palm Oil Mill Effluent (POME) value can be seen in Table 2 and Figure 2:

Table 2: Effect of Different Doses of Moringa (Moringa oleifera) Seed Powder on TSS (Total Suspended Solid) Palm Oil Mill Effluent (POME) Value

		Test (mg/L)			Amount	Avereage
No.	Treatment	R1	R2	R3		
1.	Moringa Powder 0 g (P0)	2072	1728	2072	5872	1957,33[b]
2.	Moringa Powder 1 g (P1)	1672	1326	2542	5540	1846,67[b]

3.	Moringa Powder 2 g (P2)	1990	1726	2632	6348	2116,00[b]
4.	Moringa Powder 3 g (P3)	1860	1180	2262	5302	1767,33[b]
5.	Moringa Powder 4 g (P4)	423	336	320	1079	359,67[a]

Description: Numbers followed by the same letter in the same column are not significantly different in the test BNT 5%

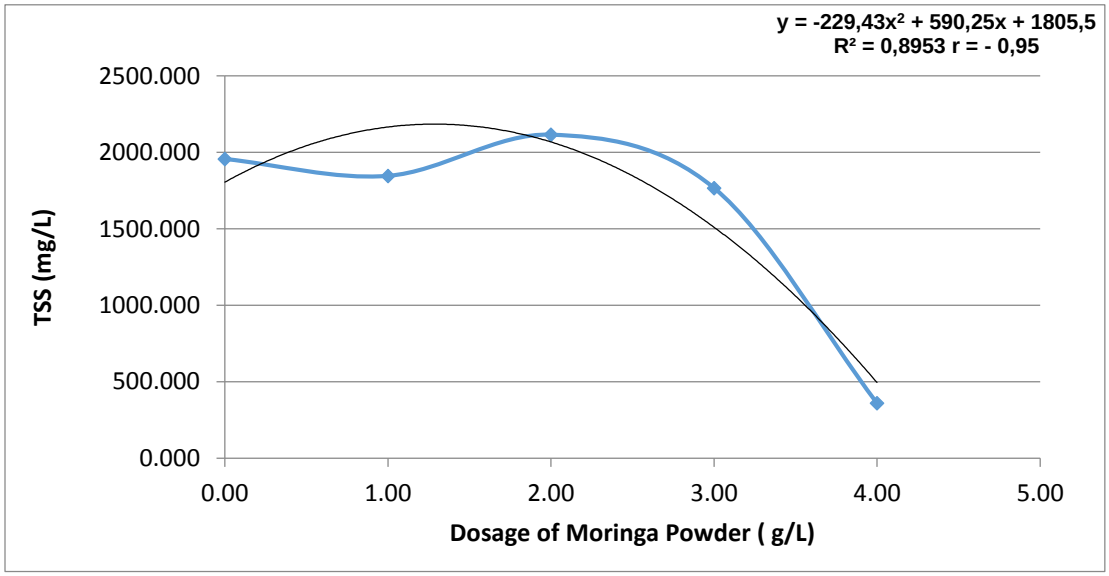

Figure 2. The Relationship Between The Dose Of Moringa Seed Powder And Changes In The Value Of TSS (Total Suspended Solid) POME Solution

Based on the data above, it can be seen that the highest value of TSS was found in treatment P2 (Moringa seed powder 2.00 g/L) with a TSS value of 2116.00 g/L. This value was not significantly different from other treatments except for the P4 treatment (Moringa seed powder 8.00 g/L). While the smallest value of TSS for treatment with Moringa powder was found in treatment P4 (Moringa powder 8.00 g/L) with a value of 359.67 mg/L. This P4 treatment was significantly different from all existing treatments. Figure 2., shows that the addition of a dose of Moringa powder causes a decrease in the TSS value in the POME solution. Based on the results of the correlation test, it can be seen that the relationship between increasing the dose of Moringa seed powder and decreasing the TSS value is very strong with a value of r = -95. This decrease is as a result of the occurrence of ionic bonds between the cations present in Moringa powder particles and the anions present in the sludge so that they can be precipitated. Yap et el. (2021), stated that the decrease in TSS value was due to anionic organic molecules (POME solids) reacting directly with cationic species

contained in Moringa powder extract. This causes unstable particles to form larger flocs and can be deposited easily by gravity.

Gea et al. (2019), reported that the concentration of Moringa seeds 50 mg/L, 100 mg/L and 150 mg/L was able to reduce the TSS value of cattle farm waste. This proves that the provision of positively charged Moringa seed coagulant will interact with negatively charged particles in the waste to form flocs through the adsorption mechanism (Sari et al., 2017).

BOD (Biological Oxygen Demand)

The results of the analysis of the effect of Moringa seed powder on the value of Palm BOD (Biological Oxygen Demand) Oil Mill Effluent (POME) are visually shown in Table 3 and Figure 4.

Tabel 3 . Effect of Different Doses of Moringa (Moringa oleifera) Seed Powder on BOD (Biological Oxygen Demand) Palm Oil Mill Effluent (POME) Value

		Test (mg/L)			Amount	Average
No.	Treatment	R1	R2	R3		
1.	Moringa Powder 0 g (P0)	245	258	225	728	242,67[a]
2.	Moringa Powder 1 g (P1)	203	214	232	649	216,33[b]
3.	Moringa Powder 2 g (P2)	225	212	221	658	219,33[b]
4.	Moringa Powder 3 g (P3)	213	219	213	645	215,00[b]
5.	Moringa Powder 4 g (P4)	212	231	221	664	221,33[b]

Description: Numbers followed by the same letter in the same column are not significantly different in the test BNT 5%

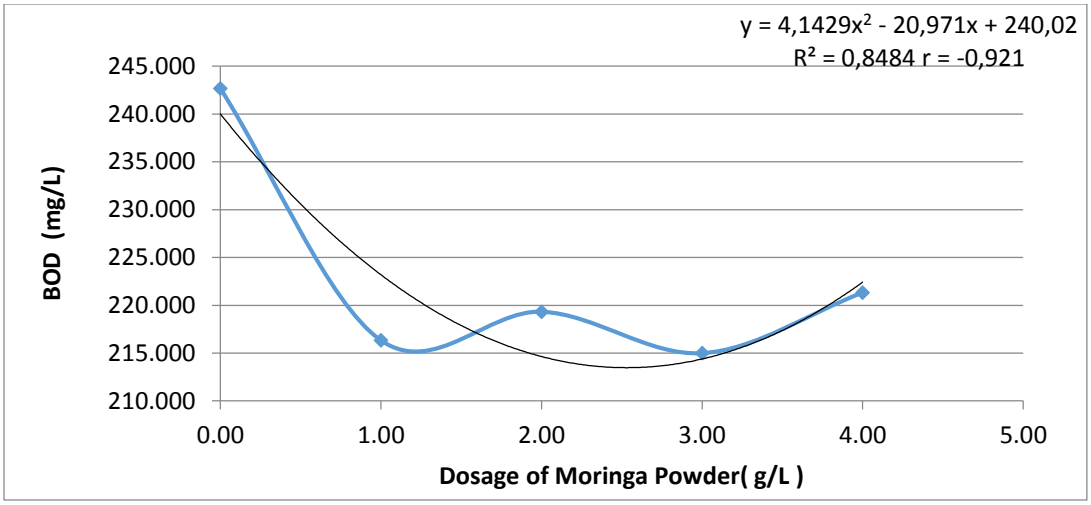

Figure 3. Relationship between Moringa Powder Dose Increase and Changes in BOD (Biological Oxygen Demand) POME. Solution.

Table 3 shows that the effect of treatment with Moringa seed powder on the POME value showed the highest value in the P0 treatment (without Moringa seed powder) with a value of 242.67 mg/L`. This treatment was significantly different from all other treatments. Meanwhile, the lowest value was found in the P3 treatment (3.00 g Moringa powder) with a COD value of 215.00 mg/L. This treatment was not significantly different from other treatments except for P0.

As seen in Figure 3, the pattern of changes in the BOD value of the POME solution tends to decrease from the P0 treatment (without moringa powder) and then increases again in the P4 treatment (4.00 g/L moringa powder). A similar pattern was also reported by Rustiah and Indriani (2018), which stated that the increase in the coagulant dose of Moringa seed powder in the COD reduction process of laundry service waste solution had an optimal value at 2.4 grams with a decrease in the percentage of 30.14%. Meanwhile, when the coagulant was added with a weight of 3 grams, the BOD level increased again with a decreased presentation of 29.43%. This is presumably because in this solution there is no longer a balance between the number of POME particles that can be bound by the negatively charged moringa powder coagulant. Thus, the presence of Moringa powder increases the BOD value of the POME solution. This is in line with the opinion of Hidayat (2009) which stated that the protein contained in Moringa seeds is a cationic polyelectrolyte flocculant. These cationic compounds are dissolved in positively charged water with negatively charged particles causing water turbidity, causing flocs to enlarge and precipitating

particles to cause water turbidity. Gautam and Saini (2020) also stated that dragon fruit is a type of plant that contains organic polymers (organic coagulants).

Heavy Metal Content Fe

The results of the analysis of the effect of Moringa seed powder on the Fe content of Heavy Metals in Oil Mill Effluent (POME) are visually shown in Table 4 and figure 4.

Tabel 4 . The Effect of Different Doses of Moringa (Moringa oleifera) Seed Powder on Heavy Metal Content of Fe in Palm Oil Mill Effluent (POME)

		Test (mg/L)			Amount	Average
No.	Treatment	R1	R2	R3		
1.	Moringa Powder 0 g (P0)	1,24	1,02	1,98	4,24	1,41[a]
2.	Moringa Powder 1 g (P1)	0,89	0,97	0,93	2,79	0,93[b]
3.	Moringa Powder 2 g (P2)	0,87	0,98	0,83	2,68	0,89[b]
4.	Moringa Powder 3 g (P3)	1,21	1,12	0,87	3,20	1,07[b]
5.	Moringa Powder 4 g (P4)	1,02	1,02	0,98	3,02	1,01[b]

Description: Numbers followed by the same letter in the same column are not significantly different in the test BNT 5%

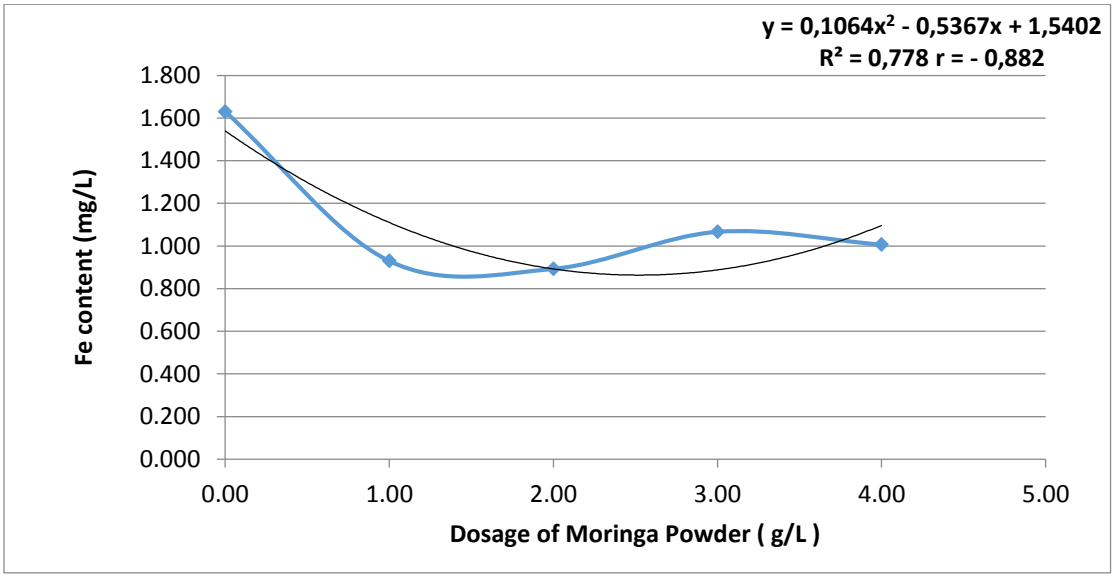

Figure 4. The Relationship Between The Dose Of Moringa Seed Powder And Changes In The BOD (Biological Oxygen Demand) POME Solution.

Table 4 indicated that the highest value of Fe solubility in POME was found in the P0 treatment (without giving Moringa powder) with a value of 1.41 mg/L. The P0 treatment was significantly different from all other treatments. While the lowest value was found in the P2 treatment (moringa powder 2.00 g/L) with a value of 0.89 mg/L. The treatment was not significantly different from other treatments, except for P0 treatment. This shows that the administration of Moringa seed powder at a dose of 2.00 g/L in POME solution has an effect that tends to be the same as other higher doses. Based on Figure 4, it can be seen that the pattern of changes in the solubility value of Fe concerning the increase in the dose of Moringa powder shows a tendency to be negatively correlated. Thus, the higher the dose given, the tendency to lower the solubility value of Fe metal in POME. This correlation is classified as very strong because it has a value of r = - 0.88. The same thing was also stated by Mustika et al. (2018), that the addition of moringa seeds to well water can reduce the solubility of heavy metal Fe by 38.96%. This is because the seeds of Moringa (Moringa oleifera) contain rhamnoxyloxy benzyl isothiocyanate which is effective for adsorbing dissolved metals (Dulanlebit, et al. 2020).

Conclusion

From this research it can be concluded the following:

1. The effect of giving Moringa seed powder to the Palm Oil Mill Effluent (POME) solution causes a decrease in the pH value of the solution. The optimal value of the dose used is 2 g/L. The same thing also happened to the TSS value of Palm Oil Mill Effluent (POME), the research treatment caused a decrease in the TSS value with an optimal dose of 4 g/L. Furthermore, the effect of giving Moringa powder causes a decrease in BOD of Palm Oil Mill Effluent (POME) solution, with an optimal dose of 1 g/L.

2. The effect of giving Moringa seed powder on the solubility of Fe Palm Oil Mill Effluent (POME) causes a decrease in the solubility of these elements. The optimal dose was found at a dose of 1 g/L.

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