The Effect of Using Milk Sludge in Liquid Waste from Dairy Farming on Organic Soil Ingredients/Soil Conditioner

Ellin Harlia[1](✉), Amelia Dwi Lestari[1], Yuli Astuti[1], Eulis Tanti Marlina[1], Gina Chynthia Kamarudin Puteri[1], Oki Imanudin[1], and Mieke Rochimi Setiawati[2]

[1] Faculty of Animal Husbandry, Universitas Padjadjaran, Sumedang, Indonesia
ellin.harlia@unpad.ac.id

[2] Faculty of Agriculture, Universitas Padjadjaran, Sumedang, Indonesia

Abstract. Milk sludge is a source of carbon that can be used together with the liquid waste of dairy farms into products, namely organic soil reformers. Organic soil-forming products can be used in the treatment of liquid waste from dairy farms and milk sludge from the dairy processing industry. This study aims to determine the plowing of the dose of milk sludge in the liquid waste of dairy farms that are most effective against the content of organic soil improvement. The research was carried out experimentally using 4 treatments, namely P1 (concentration 0%), P2 (concentration 10%), P3 (concentration 20%), and P4 (concentration 20%) and four repeats. The data will be analyzed using a Complete Randomized Design (RAL). The changes observed were the content of C-organic, pH, and the number of coliform bacteria based on estimator and booster tests. The results of the study showed that all treatments had different influences results on the content of C-organic, pH, and organic soil-forming coliform bacteria. Milk sludge in the liquid waste of dairy farms with a concentration of 30% at the time of observation of week 3 produced an organic soil reformer with the content of C-organic, pH, and coliform bacteria in accordance with the minimum technical requirements of the Ministry of Agriculture No. 261 of 2019.

Keywords: Dairy Farm Liquid Waste · Milk Sludge · Organic Soil Reformer

1 Introduction

Milk sludge and liquid waste from dairy farms are the results of the milk processing and dairy farming industries, which can seriously impact the environment. The analysis conducted at the Ruminant Animal Nutrition and Food Chemistry Laboratory of the Faculty of Animal Husbandry Unpad in 2021 showed the milk mud still contains nutrients. Namely, with a protein content of 22.46% and fat of 4.96%, as well as C-organic 55.61% obtained from the results of analysis at the Laboratory of Soil Science and Land Resources, Faculty of Agriculture Unpad, proves that the content of milk mud can still be used as an effort to overcome pollution in the environment. Liquid waste originating from the dairy farming industry contains pH 7.27, nitrate 2.45 Mg/L, NH3-N 5.10 Mg/L,

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H2S 14.74 Mg/L, COD 2830 Mg/L, and BOD 4632 Mg/L [5]. Milk slurry and dairy farm effluent are not permitted to be discharged directly into the soil or plants without prior treatment. The problems experienced by the dairy farming industry and the dairy processing industry related to the waste produced have received a solution from the government in Kepmentan 261/KTPS/SR.310//M/4/2019.

The government has explained in the Ministry of Agriculture that the waste from the dairy farming industry and the dairy processing industry is about the requirements that must be met before disposing of the waste into the environment or the requirements for making a product. Therefore, the potential of milk sludge and dairy farm wastewater can be reformulated into a useful product. The product requirements that can be easily achieved after processing milk sludge from the milk processing industry and liquid waste from the dairy farming industry are Organic Soil Improvement (PTO). An *organic improver* is a soil enhancer from organic or mineral materials produced without chemical engineering. Organic soil improvers generally come from plant or animal residues that can be used to improve soil properties [10].

Organic soil improvers have requirements for organic C content: a minimum of 10%, pH 4–9, and Escherichia coli bacteria content < $1x10^2$ (Kepmentan, 2019). The selection of soil improvement materials needs to be calculated properly to get good results. *Organic matter* is a soil enhancer that can meet these requirements. Using organic matter as a soil amendment can also support soil carbon conservation to support climate change mitigation by increasing carbon stores in the soil and suppressing the release of carbon in the form of greenhouse gases. Organic soil retainers have the function of being able to improve soil structure, change soil capacity, and hold and pass water. They can improve the ability of the soil to hold water and nutrients so that they are not easily lost [3].

The utilization of milk sludge in liquid waste is expected to be used as a source of soil-enhancing organic matter. Organic soil improver can be used as a solution to the problems found in the dairy processing industry and the dairy farming industry. The content of organic soil improver with milk mud and liquid waste from dairy farms is expected to meet the requirements of the Ministry of Agriculture in 2019 within four weeks of observation. This study was conducted to find out more about the effect of using milk sludge in the liquid waste of dairy farms on the content of organic soil enhancers.

2 Materials and Methods

2.1 Materials

The materials used in this study include 40 L of milk mud from PT. KPBS Pangalengan milk (SKP), 40 L of dairy farm liquid waste from Pangalengan, Lactose broth: *Lactobacillus acidophilus*) from OXOID UK, (Eosin Methylene Blue Agar) EMBA from OXOID UK, alcohol 70% and aquadest.

2.2 Methods

Sampling Was Done by Homogenizing the Milk Sludge and Dairy Farm Liquid Waste at 0 weeks of Observation. The Sample Was Put into a 20 L Jar According to the Treatment

P1 = 0% (0 kg of Milk Mud); P2 = 10% (1 kg of Milk Slurry); P3 = 20% (2 kg of Milk Slurry); P4 = 30% (3 kg of Milk Slurry) Each Added 10 L of Dairy Cattle Waste. Milk Slurry and Liquid Waste from Dairy Farms that Have Been Homogenized Are Subjected to an Aerobic Fermentation Process with the Help of an Aerator. Milk Sludge Samples in the Liquid Waste of Dairy Farms Were Observed for Changes in C-organic Content, pH, and Coliform Bacteria at 0, 1, 2, and 3 weeks of Observation.

Variable Measurement

C-organic Content. The C-organic Content Was Obtained by Carrying Out the Walkey and Black Method with the Principle that Organic Carbon Was Oxidized by Dichromate in an Acid Atmosphere. The Chromium III Formed Was Equivalent to the Oxidized Organic C and then Measured Spectrometrically.

PH Value. Measurement of the pH Value is Carried Out with the Following Work Procedures. Prepare a pH Meter. The Cathode End of the Indicator is Cleaned with Distilled Water, After Which It is Dried with a Cloth or Tissue. Furthermore, the pH Meter is Calibrated Using Buffer Solutions 4 and 7 Which Are Immersed at the Cathode End. The pH Meter Can Be Used on Samples, with Each Measurement Washed First with Distilled Water.

Presence of MPN Coliform Bacteria and Amplifiers. Presumptive Test. Prepare 15 Test Tubes Containing 10 ml of Sterile Lactose Broth Media Equipped with Durham Tubes. The Test Tubes Are Coded According to the Observations. Samples Were Put into Test Tubes of 10 ml, 1 ml, and 0.1 ml with a Code that Corresponds to the Observations. The Test Tube Containing the Sample Was then Incubated for 24 h at 37 °C. After the Incubation Process for 24 h, the Tube that Shows a Positive Reaction is Indicated by the Presence of Gas in the Durham Tube. Samples that Reacted Positively Were Continued in the Confirmed Test.

Confirmed Test. The Results of the Estimator Test Are Continued with the Reinforcing Test. The Samples that Reacted Positively Were then Planted on Eosin Methylene Blue Agar (EMBA) Media by Scratching Using a Sterile Loop. Samples Scratched on EMBA Media Are then Incubated at 37 °C for 24 h. The Results of the Reinforcement Test Showed that the Escherichia Coli Bacteria Grew in Metallic Green and Greenish-Red with a Metallic Luster, and Samples with Pink Color Came from Other Coliform Bacteria.

Statistic Analysis. This Study Was Carried Out Using a Completely Randomized Design (CRD) Method with Four Treatments, Namely the Addition of Milk Sludge as Much as 0% (P0), 10% (P1), 20% (P2), and 30% (P3) and Was Repeated Three Times on Observation Time for Four weeks (0, 1, 2, 3 weeks). The Research Data Obtained with the Observed Variables, Namely the Organic C Content and pH, Were Analyzed Using Analysis of Diversity Prints (Annova). if the Treatment Showed a Significant Effect on These Variables, It Was Continued Using the Tukey Test as a Further Test of the Analysis. In Addition, Coliform Bacteria Were Analyzed Using Non-parametric Statistics, Namely the Kruskal Wallis Test.

3 Results and Discussion

The average yield of C-organic content in the milk sludge in the liquid waste of dairy farms at different observation times ranged from 2.59%–14.40%. The variance analysis showed that all milk sludge concentrations in the liquid waste of dairy farms during the third week of observation had a significant effect. The average results of organic C content with the Tukey multiple area test in the third week of observation showed that the treatment of milk sludge in the liquid waste of dairy farms was 0% (P1), 10% (P2), and 20% (P3) affected significantly was higher than P4 (30%) which was 14.40. This indicates a significant difference in the addition of milk sludge in the liquid waste of dairy farms compared to no addition, which means that adding milk sludge in the liquid waste of dairy farms increases the organic C content.

Milk sludge is a source of organic matter containing 55.61 C-organic (Laboratory of Soil Science and Land Resources, Faculty of Agriculture Unpad). One of the causes of the decrease in the C-organic content of milk sludge in the liquid waste of dairy farms at different observation times is the overhaul of organic matter by bacteria. Overhauling organic matter can occur under aerobic and anaerobic conditions [4]. Therefore, the presence of indigenous bacteria remodeled the C-organic content of milk sludge in the liquid waste of dairy farms at different observation times.

Indigenous bacteria live in the wild and have various benefits for humans and the environment. Indigenous bacteria have the function of degrading waste, controlling plant life, and acting as antibiotics [1]. Adding organic matter containing high organic C can increase microbial proliferation because organic matter is the main energy source for microbial activity. According to [15], adding organic matter to the soil will increase some plant nutrients, causing a temporary shortage of organic C content. However, the process of adding organic matter results in the weight and content of organic matter being reduced. The study proved that organic C levels decreased until day 15 and increased sharply on day 28.

C-organic content

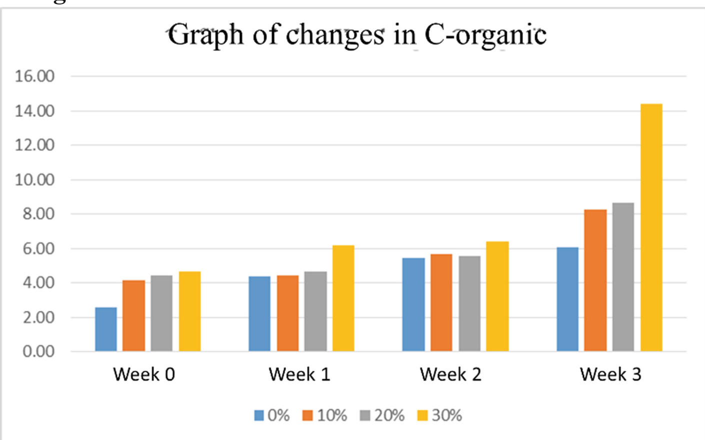

Fig. 1. Graph of changes in C-organic content with an observation time of 3 weeks.

Acidity (pH)

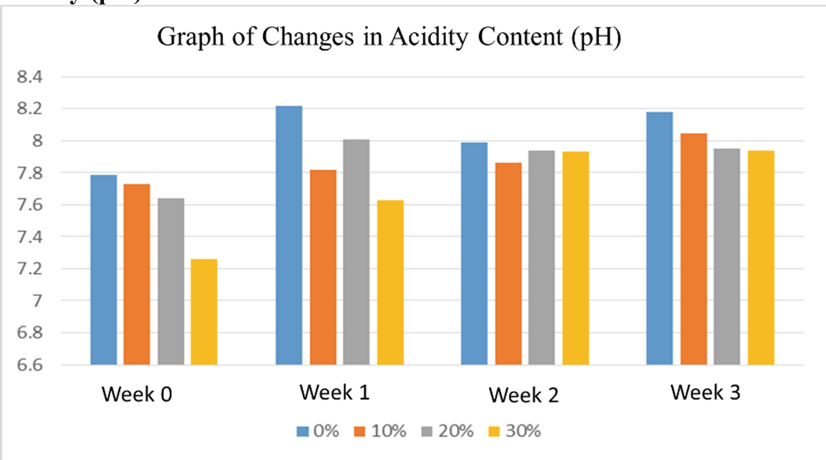

Fig. 2. Graph of Changes in Acidity Content (pH) with an observation time of 3 weeks.

Sources of organic matter contain water, mineral matter, and organic compounds. Milk sludge in the liquid waste of dairy farms is included in organic carbohydrate compounds, namely sugar and starch, pectin, hemicellulose, and cellulose. Carbohydrates are the largest organic compounds making up the organic matter because they contain $> 50\%$ of the total dry weight of organic matter [15] The process of decomposition of organic compounds is influenced by the compounds contained in the organic material. Carbohydrates have the lowest resistance compared to other organic compounds. Besides that, the C-organic content of the material can affect the decomposition rate of organic matter. Carbohydrates will undergo a process of catabolism (decomposition) which will produce organic acids. The increase in the C-organic content of milk sludge in the liquid waste of dairy farms during the third week of observation is in line with research [11, 13, 14] which explains that the C-organic content of the soil is caused by the decomposition process of organic matter so that organic matter decomposition occurs. The yield of these organic acids indicated that the C-organic content of the soil could increase due to the presence of organic acids. Hence, the C-organic content of milk sludge in the liquid waste of dairy farms at different observation times is shown in Fig. 1. The results of the C-organic content at the third week of observation with a concentration of 30% by the requirements of Ministry of Agriculture No. 261 of 2019 in the manufacture of organic soil improvers, which is a minimum of 10% (Ministry of Agriculture, 2019) (Fig. 2).

The average pH value produced by milk slurry in the liquid waste of dairy farms at different observation times between treatments ranged from 7.23 to 8.32. The analysis of variance showed that all concentrations of milk sludge in the liquid waste of dairy farms at 0 and 1 week of observation had a significant effect ($P < 0.05$). The average results of C-organic content with the Tukey multiple region test at week 0 of observation showed that the treatment of milk sludge in the liquid waste of dairy farms was 10% (P2), 20% (P3), and 30% (P4) affected significantly ($P < 0.05$) was higher than P1 (0%)

Presence of MPN Coliform Bacteria and Amplifiers

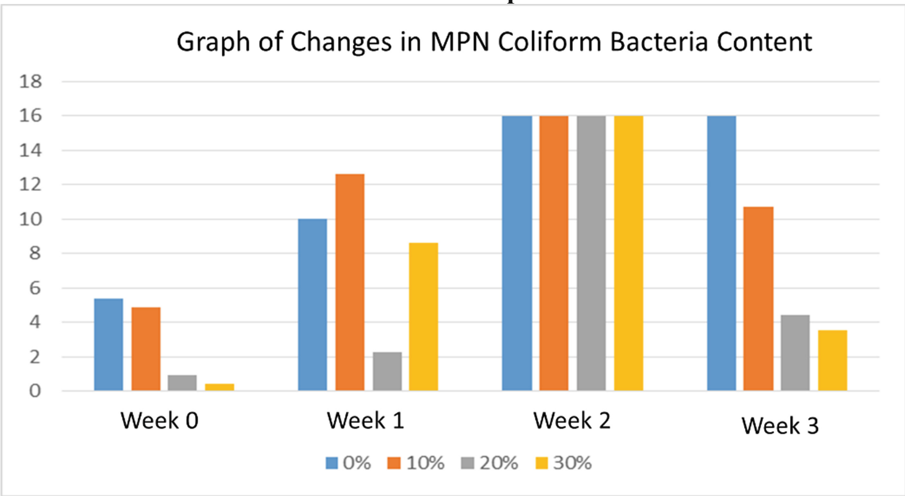

Fig. 3. Graph of Changes in MPN Coliform Bacteria Content with 3 Weeks of Observation Time.

which was 7.79. Tukey's area test was also carried out at the time of observation week 1 with concentrations of 0% (P1) and 30% (P4), indicating that the treatments did not have a significant difference ($P > 0.05$). This states that the pH of all concentrations of milk sludge in the liquid waste of dairy farms follows the requirements for making organic soil enhancers as contained in Ministerial Decree No. 261 of 2019, which is a minimum pH of 4–9 organic soil enhancers (Ministry of Agriculture, 2019).

Changes in the pH value of milk sludge in dairy cattle effluent at different observation times can be caused by CO2 concentration, temperature, carbonate and bicarbonate concentrations, and the decomposition process of organic matter [9]. Organic soil improver can be applied to the soil after fulfilling the requirements of Kepmentan No. 261 of 2019. The process of applying organic soil enhancers needs to pay attention to the neutral pH of the soil. The study's results showed that all concentrations of milk sludge in the liquid waste of dairy farms had met the requirements for making organic soil improvers. According to the Department of Agriculture, in 2021, the neutral pH of the soil will be 6.5–7.8. Soil with a neutral pH is ideal in the content of organic compounds, microorganisms, nutrients, and minerals in optimal conditions. Soil pH is critical to pay attention to because it can affect the nutrient content plants need in a certain amount to grow and survive disease [8].

MPN coliform bacteria and estimators in the milk sludge in the liquid waste of dairy farms at different observation times resulted in the MPN values as listed in Fig. 3. The results of the following study were non-parametric statistical tests using the Kruskal Wallis test to test for significant differences between a group of independent variables and the dependent variable. The results of the presence of MPN coliform bacteria obtained through analysis of variance showed that the treatment at weeks 0 and 3 had a significant effect on the content of organic soil enhancers.

Coliform bacteria were tested qualitatively, which consisted of a presumptive test and a confirmed test. The estimator test was carried out to detect the presence or absence of coliform bacteria based on the formation of acid and gas caused by lactose fermentation by Coli group bacteria. The formation of gas in the Durham tube results from lactose fermentation and produces lactic acid. The results of lactose fermentation do not always indicate the presence of coliform bacteria because lactose can be fermented by other microbes, such as lactic acid. An actual test will be carried out [7].

An actual test was carried out to confirm the presence of Escherichia coli bacteria in samples with EMBA (Eosin Methylene Blue Agar) media. Changes in color colonies on EMBA media from metallic green to pink or a mixture of both colors. Pink colonies on EMBA media indicated that the sample did not contain Escherichia coli bacteria. Changes in the color of the colony at week 2, which is pink, are caused by the presence of non-fecal coliform bacteria and dead fecal bacteria. According to [12] research, coliform bacteria can multiply in media with adequate nutritional conditions, and coliform bacteria will die when these nutrients have been consumed, making conditions unsuitable. The main factors that affect the growth of Escherichia coli bacteria, according to (WHO, 2015), are temperature, water activity, pH, and oxygen availability.

The results of the study at week 0 of observation showed that the milk sludge in the liquid waste of dairy farms at different times of observation contained Escherichia coli bacteria characterized by the presence of metallic green colonies on the EMBA media. The results of the study at the incubation time of week 2 showed that the EMBA media was pink, which meant that the bacteria were non-fecal coliforms. The statement [2] that incubating bacterial colonies on pink EMBA media means that the sample water contains *Citrobacter* bacteria, a non-fecal coliform. The statement proves that the milk slurry in the liquid waste of dairy farms at the incubation time of the second week has met the minimum technical requirements for using organic soil improvers, as stated in Kepmentan No. 261 of 2019. These results show that the milk sludge in the liquid waste of dairy farms can already be used as an organic soil enhancer by the minimum technical requirements of Escherichia coli in the Minister of Agriculture Decree No. 261 of 2019, which contains Escherichia coli bacteria $<$ 1 x 102 MPN/ml.

4 Conclusions

1 Milk sludge in dairy cattle effluent at different observation times with concentrations of 0%, 10%, 20%, and 30% gave different results on C-organic content, acidity (pH), and coliform bacteria to improve organic soil resulting from.

2 Milk sludge in dairy farm wastewater with a concentration of 30% during the third week of observation resulted in C-Organic values, acidity (pH), and coliform bacteria in accordance with the minimum technical requirements for organic soil improvers in Kepmentan No. 261 the Year 2019.

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