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Evaluation of Various Concentrations of Rumen Waste in making Liquid Organic Fertilizer

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Slaughterhouses are known as places to produce meat for human consumption. On the other hand, slaughterhouses produce livestock waste, one of which is rumen. The rumen's high nutrient and microbial content provide an excellent opportunity for its use as liquid organic fertilizer for plant growth and development. However, evaluation of rumen addition concentration during the manufacture of liquid organic fertilizer is still scarce and needs to be carried out. Therefore, this research aims to obtain a suitable rumen addition formulation for making liquid organic fertilizer. Rumen waste was varied in 4 concentrations, namely 20%, 40%, 60% and 80%. Supporting ingredients, such as laos, ginger, turmeric, galangal, and rice washing water, are mixed with the rumen, which is then incubated for 15 days to obtain liquid organic fertilizer. Analysis of total nitrogen content, C/N ratio, total phosphate, total potassium, total microbes, and physical characteristics was carried out to evaluate the quality of liquid organic fertilizer. The results showed that the addition of 80% rumen was able to play a role in producing liquid organic fertilizer with high total nitrogen (2.35%), low C/N ratio (6.05), high total phosphate (1.19%), and high total potassium (1.75%). Furthermore, liquid organic fertilizer made with the addition of 80% rumen contains high total microbes (5.5 x 1010 CFU/mL), is bright brown, yellowish in color, and has an earthy aroma. This research indicates that adding 80% rumen can produce good quality liquid organic fertilizer. This information can be the basis for further research regarding the rumen potency as an ingredient of organic fertilizer.

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1. Introduction

In Livestock are a source of food for humans. They are generally slaughtered in slaughterhouses and used for human consumption, especially meat. Kefalew & Lami (2021) Explain that a slaughterhouse is where animals are killed for meat production. Good-quality meat can be obtained from animals whose welfare is considered disease-free (Rodli et al., 2023). Attention to slaughterhouse quality standards is also essential in producing good-quality meat (Aprilia Anggraini et al., 2021). One way to do this is to adapt to the quality standards required by Indonesia's national standardization body (SNI, 1999).

One of the things produced by slaughterhouses is livestock waste. According to Sulistyaningsih (2020), livestock waste is left over from slaughterhouse activities. Other literature states that slaughterhouse waste consists of 70-75% liquid waste, which results in increased organic matter and high amounts of dissolved solids in the waste (Azadbakht et al., 2023; Roberts et al., 2009). Unfortunately, livestock waste can be a source of problems for the environment if it is not utilized. Untreated livestock waste can cause water, air, and soil pollution (Nurkholis et al., 2019; Sastro et al., 2013). Nurfitria & Febriyantiningrum (2022) explained that livestock waste is a source of environmental problems such as unpleasant odors and disease. Kefalew & Lami (2021) also mentioned the same thing, stating that livestock waste can cause environmental pollution and harm human health.

Types of livestock waste are feces, blood, bones, fat, and urine (Aniebo et al., 2009). Besides that, rumen is also one of the leading livestock wastes, contributing to high organic levels and can cause public health and environmental damage (Bhunia et al., 2019). The rumen is part of the digestive system, like an animal's stomach. The rumen contains a pre-digestive chamber where symbiotic microorganisms gather to begin the breakdown of food. On the other hand, the rumen of ruminant livestock (cows, buffaloes, goats, and sheep) still contains many microbes that can be useful in breaking down organic matter (Nurkholis et al., 2019). This helpful thing means that the rumen can still be used as an ingredient in making fertilizer, which plays a role in plant growth and development.

Rumen contains microbes and substances beneficial to plants, such as nitrogen, phosphate, and potassium. Yusnaini et al. (2022) explained that animal-based waste, such as rumen, can be used as an ingredient for making fertilizer because it contains nitrogen, phosphate, and potassium, essential for plants and soil fertility. The rumen also contains beneficial micronutrients, such as Zn, Fe, and Cu (Adediran et al., 2004; Bhunia et al., 2021). Research showed that using livestock waste-based fertilizer of 20-50 tons per hectare of land can improve Hungary's corn quality and productivity (Ragályi & Kádár, 2012). Using slaughterhouse waste, such as rumen, as organic fertilizer can minimize environmental pollution and increase soil fertility (Bhunia et al., 2019).

Organic fertilizer is beneficial in several ways, such as increasing agricultural production, reducing environmental pollution, and improving sustainable soil quality (Yusnaini et al., 2022). Liquid forms of organic fertilizer are more widely applied in agriculture today. Liquid organic fertilizer is a solution of organic material produced from the decomposition of plant residues and animal and human waste, which contains more than one nutrient element (Safuan et al., 2023). Liquid organic fertilizer can protect plants from chemical residues commonly used in fertilization (Sulistyaningsih, 2020). Liquid organic fertilizer also has many other benefits, such as increasing the formation of leaf chlorophyll, expanding the ability of plants to photosynthesis and absorbing nitrogen from the air, and increasing plant vigor, making plants more potent and more robust (Safuan et al., 2023).

Other researchers have studied the effect of liquid organic fertilizer on chili plants' germination, growth, and yield (Vijayakumar et al., 2019). Most researchers use liquid organic fertilizer based on plant materials and rarely use animal materials, such as livestock waste. The latest information obtained from Nurfitria & Febriyantiningrum (2022) shows that cattle farm waste in Tuban Regency has the potential to be used as raw material for making liquid organic fertilizer. However, detailed studies regarding the evaluation of rumen addition concentrations correlated with chemical and physical properties and microbes from liquid organic fertilizers still need to be made available. Therefore, this research aims to obtain the appropriate rumen addition formulation for making liquid organic fertilizer.

2. Method

Materials

This research used rumen waste obtained from the slaughterhouse in the Jungke area, Karanganyar, Central Java, Indonesia. Several natural ingredients, such as laos, ginger, turmeric, and galangal, washing water from organic rice, and molasses obtained from farmers in the Mojogedang area, Karanganyar, Central Java, Indonesia, were also used in this research. Several chemical reagents are used in the product analysis.

Methods

Preparation of liquid organic fertilizer

In the initial stage, 50 grams of laos, 50 grams of ginger, 50 grams of turmeric, and 50 grams of galangal are ground until smooth, followed by adding 1 L of water. Then, the extract mixture is mixed with 20 L of organic rice washing water. Next, molasses (1 L) was added to produce a mix of herbal extract-rice washing water-molasses. In a separate place, rumen waste is mixed with water and filtered to take the filtrate. Then, the rumen waste filtrate (6 L) is mixed with water (4 L), which is then combined into a mixture of herbal extract-rice washing water-molasses at various concentrations, namely 20%, 40%, 60%, 80% (v /v). After that, the mixture is incubated for 15 days at room temperature to produce liquid organic fertilizer.

Visual observation

Liquid fertilizer was physically and visually observed. The parameters observed were the color and aroma of the liquid fertilizer. In addition, the presence of larvae or insects in liquid fertilizer was also observed visually in this study.

Total nitrogen analysis

Liquid fertilizer was evaluated based on total Nitrogen content using the method of Page et al. (1982). This method obtains total nitrogen levels from organic N, N-NH4, and N-NO3 accumulation.

a) Determination of organic N

In determining organic N, liquid fertilizer (0.25 grams) is reacted with a mixture of selenium (0.25 grams) and H2SO4 (3 mL), which is then left for 2-3 hours. Then, the mixture was extruded at 150oC to 350oC for 3 hours and cooled to room temperature. Then, distilled water (100 mL) was added to the mixture and distilled until the liquid volume reached 75 mL. Then, the distillate is mixed with several reagents, such as 40% NaOH (20 mL), 1% boric acid (10 mL), and a Conway indicator (3 drops). After that, the mixture was titrated with 0.05 N H2SO4 until the solution changed from green to light pink. The titration volume is recorded and compared with the blank and calculated based on formula (1).

$$\text{Organic N } (\%) = (A - A_1) \times 0{,}05 \times 14 \times 100/(\text{mg sample}) \times fk$$

with A: titration volume (mL); A1: blank volume (mL); fk: correction factor

b) Determination of N-NH4

In determining N-NH4, 1 gram of liquid fertilizer is added to 100 mL of distilled water, which is then filtered to a volume of 75 mL. Then, the distillate is mixed with 10 mL of 40% NaOH, 10 mL of 1% boric acid, and 3 drops of Conway indicator. After that, the mixture was titrated with 0.05

N H_2SO_4 solution until the solution changed from green to light pink. The titration volume is recorded and compared with the blank and calculated based on formula (2)

$$N\text{-}[NH]_4\ (\%)=(B-B_1)\ x\ 0{,}05\ x\ 14\ x\ 100/(mg\ sample)\ x\ fk$$

with B: titration volume (mL); B1: blank volume (mL); fk: correction factor

c) Determination of N-NO3

In determining N-NO3, the material used is the remainder of the mixture used in determining N-NH4. The remaining mixture was added with distilled water (100 mL) and re-distilled until it reached a volume of 75 mL. Then, the distillate was reacted with 10 mL of 1% boric acid, 3 drops of Conway indicator, and 2 grams of Devarda alloy reducing agent. After that, the mixture was titrated with 0.05 N H_2SO_4 solution until the solution changed from green to light pink. The titration volume is recorded and compared with the blank and calculated based on formula (3)

$$N\text{-}[NO]_3\ (\%)=(C-C_1)\ x\ 0{,}05\ x\ 14\ x\ 100/(mg\ sample)\ x\ fk$$

with C: titration volume (mL); C1: blank volume (mL); fk: correction factor

After determining the levels of organic N, N-NH4, and N-NO3, total Nitrogen levels can be determined using formula (4)

$$N\text{-total}\ (\%)=(N_{organic}-[NNH]_4)+[NNH]_4+[NNO]_3$$

Total carbon analysis and determination of the C/N ratio

The total carbon content in liquid fertilizer was evaluated using official method (Horwitz, 2000). Initially, 1 gram of liquid fertilizer was reacted with 5 mL of 2 N $K_2Cr_2O_7$ solution and 7 mL of H_2SO_4. Distilled water was added to the mixture until the volume reached 100 mL, then left for 30 minutes. After that, the absorbance of the mixture was measured using a UV-VIS spectrophotometer at a wavelength of 651 nm. Total C levels are calculated based on formula (5)

$$total\ C\ (\%)=absorbance\ of\ sample\ x\ 100/mg\ sample\ x\ correction\ factor$$

The C levels obtained are then compared with the N levels to get the C/N ratio value.

Analysis of total potassium and total phosphate

The determination of total potassium and total phosphate levels was carried out sequentially using official method (Horwitz, 2000). Initially, 0.5 grams of liquid fertilizer was reacted with 5 mL of HNO_3 and 0.5 mL of $HClO_4$, then left overnight. After that, the mixture was digested in a digestor at a temperature of 100oC. After the yellow steam runs out, the temperature increases to 200oC. Digestion ends when white steam comes out, and 0.5 mL of liquid remains. Then, the mixture was cooled and diluted to a volume of 50 mL and left overnight. Next, the mixture was filtered using the Whatman 41 filter paper to obtain a clear extract.

In the next stage, 1 mL of clear extract is mixed with 9 mL of distilled water. Then, the mixture was reacted with 200 mL of buffer solution (a mixture of 100 grams of NH4-acetate, 10 grams of titriplex II, 4 grams of titriplex I, 50 mL of acetic acid, distilled water) and 50 mL of azomethine-H (a mixture of 0.53 grams azomethine-H, 1 gram ascorbic acid, distilled water). Then, the absorbance of the mixture was observed using an Atomic Absorption Spectrophotometer instrument, and then the potassium content of the liquid fertilizer was determined based on formula (6)

total K (%) = absorbance of sample x (mL extract)/(1000 mL) x 100/(mg sample) x fp x fk

with fp: dilution factor; fk: correction factor

In a separate place, 1 mL of a mixture of liquid fertilizer with buffer solution and azomethine-H was reacted with 9 mL of coloring reagent (a mixture of 0.53 grams of ascorbic acid, 12 grams of ammonium heptamolybdate, 0.275 grams of potassium antimony tartrate, 140 mL of H2SO4, distilled water). Then, the mixture was allowed to stand for 25 minutes, and the absorbance was measured using a UV-VIS spectrophotometer with a wavelength of 693 nm. After that, the total phosphate content of liquid fertilizer is calculated based on formula (7)

Total P (%)=absorbance of sample x (mL extract)/(1000 mL) x 100/(mg sample) x fp x 31/95 x fk

with fp: dilution factor; fk: correction factor; 31: atomic weight of P; 95: molecular weight of PO4

Total plate count analysis

Total microbial levels from liquid organic fertilizer were evaluated using the total plate count method based on the description of Yunita et al. (2015). Initially, 1 mL of liquid fertilizer was added to 9 mL of distilled water to obtain a 10-2 dilution series. Then, 1 mL of the 10-2 dilution is mixed with 9 mL of distilled water to get the 10-3 dilution series, sequentially 1 mL of the 10-3 dilution is mixed with 9 mL of distilled water to get the 10-4 dilution series. Then, 1 mL of each dilution series was inoculated into a petri dish. Then, the agar plate count media is mixed into the petri dish. Then, the mixture was incubated at 37oC for 2 days. After that, the colony growth results were counted using a colony counter, and the number of microbial colonies in the liquid fertilizer was obtained.

Statistical analysis

This study used a completely randomized design with 3 replications. The significance of differences between treatments was determined using the one-way ANOVA method via SPSS v statistical software. 25 (SPSS Inc., USA). Next, the Duncan multiple range test (DMRT) method was used to evaluate differences between treatments with a significance level of 95% ($p \leq 0.05$).

3. Result and Discussion

Total Nitrogen

The essential nutrient element is nitrogen. Nitrogen builds amino acids (proteins), nucleic acids, nucleotides, and chlorophyll in plants, so if there is nitrogen, plants will grow faster (Safuan et al., 2023). Nitrogen accelerates cell growth, chlorophyll formation, and protein synthesis (Bhunia et al., 2019). Nitrogen is essential for plant growth, development, and reproduction. Nearly 75% of the absorbed nitrogen is needed to form chloroplasts in plants (del Amor, 2007). Another theory states that organic materials, such as fertilizers with a high nitrogen content, will quickly decompose in the soil (Bohara et al., 2019; Hamawi & Akhiriana, 2022). Nitrogen-degrading bacteria are usually present in fertilizers, which play a role in helping increase organic N (Phibunwatthanawong & Riddech, 2019).

This research found that the addition of 80% of rumen waste could contribute to an increase in total nitrogen in liquid organic fertilizer, namely 2.35%, the highest among other treatments ($p \leq 0.05$) (Figure 1). Nitrogen-degrading microorganisms in liquid fertilizer can influence the increase in total nitrogen. Phibunwatthanawong & Riddech (2019) explained that the increase in total nitrogen is related to the activity of nitrogen-degrading microorganisms. This result indicates that the higher concentration of rumen addition can increase the presence of microorganisms in liquid fertilizer. The total nitrogen content in this liquid fertilizer meets the quality standards for liquid organic fertilizer set by the Indonesian government, namely 2-6% (Hamawi & Akhiriana, 2022).

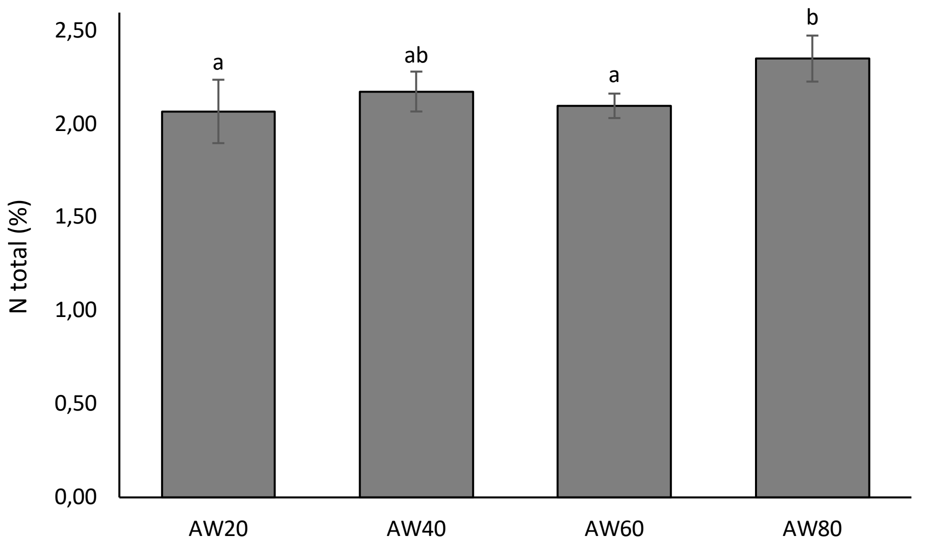

Figure 1. Total nitrogen content (N total) of liquid organic fertilizer with rumen waste. AW20: 20% rumen; AW40: 40% rumen; AW60: 60% rumen; AW80: 80% rumen. Different letters above the bar diagram indicate significant differences between treatments ($p \leq 0.05$).

The results of this research have a higher total nitrogen value than the findings of other researchers. Liquid organic fertilizer based on pineapple peel contains 1.27% nitrogen (Susi et al., 2018). Meanwhile, liquid organic fertilizer contains a total nitrogen level of 0.21% after 15 days of fermentation (Phibunwatthanawong & Riddech, 2019). Total nitrogen levels of less than 1% were also obtained by Basmal et al. (2019), who used seaweed extract as a basis for making liquid fertilizer with total nitrogen of 0.60-0.65% through inoculation for 20 days at room temperature. Hamawi & Akhiriana (2022) also found that liquid organic fertilizer applied during 30 days of kitchen waste composting contained 0.13% total nitrogen. Low total nitrogen levels may be caused by nitrogen gas fractions escaping from the system during fermentation (Sastro et al., 2013). However, other researchers have found liquid fertilizer with high total nitrogen levels, namely 6.05% total nitrogen, which was obtained from liquid organic fertilizer based on banana, mango, and pineapple peels which were fermented for 7-14 days (Widyabudiningsih et al., 2021). Differences in results are influenced by variations in raw materials for making liquid fertilizer, fermentation time, and methods for making liquid fertilizer.

C/N ratio

The C/N ratio is an essential requirement for microorganisms, which use carbon as an energy source and nitrogen as a fundamental element for the formation of proteins and constituents of cell protoplasm. The C/N ratio activates cellulolytic microbes and the proliferation of microbes that immobilize nitrogen (Phibunwatthanawong & Riddech, 2019; Satisha & Devarajan, 2007). Meanwhile, the carbon (C) content in fertilizer can be helpful as a source of nutrition for plants. It can play a role in increasing soil productivity, improving soil structure, and increasing the soil's ability to bind water. The C content also improves living systems in the soil, especially the microorganisms in the soil (Basmal et al., 2019).

Based on Figure 2, adding 60% of rumen can produce liquid fertilizer with the highest C/N ratio among other treatments, namely 10.27 ($p \leq 0.05$). Meanwhile, adding 20%, 40%, and 80% of cow rumen formed a C/N ratio of 6.42, 5.95, and 6.05, respectively (Figure 2). This result is much lower than that Phibunwatthanawong & Riddech (2019) found, namely, a C/N ratio of 16.41 in liquid organic fertilizer after 15 days of fermentation. Meanwhile, other researchers found that the C/N ratio in banana peel-based liquid fertilizer was 3.06 (Akbari et al., 2015; Safuan et al., 2023).

Bohara et al. (2019) explained that fertilizer with a low C/N ratio will decompose easily and be quickly used in the soil. Bhunia et al. (2021) said a low C/N ratio indicates high-quality fertilizer. A C/N ratio that is too high in fertilizer can slow the decomposition rate because it takes the decomposer to break down organic material. At the same time, a C/N ratio that is too low can cause the decomposer to be poisoned by ammonium (Alkoaik, 2019). This makes the C/N ratio value an essential parameter that needs to be correlated with other parameters, such as total nitrogen, phosphate, and potassium. Accurate ratio figures were presented by Phibunwatthanawong & Riddech (2019), namely, if the C/N ratio in fertilizer is less than 20, then microbes easily degrade the substrate, allowing the fertilizer to be decomposed and used more quickly. The findings in this study indicate that all cow rumen addition treatments can produce a C/N ratio in liquid fertilizer below 20, so it has the potential to be applied well to the soil.

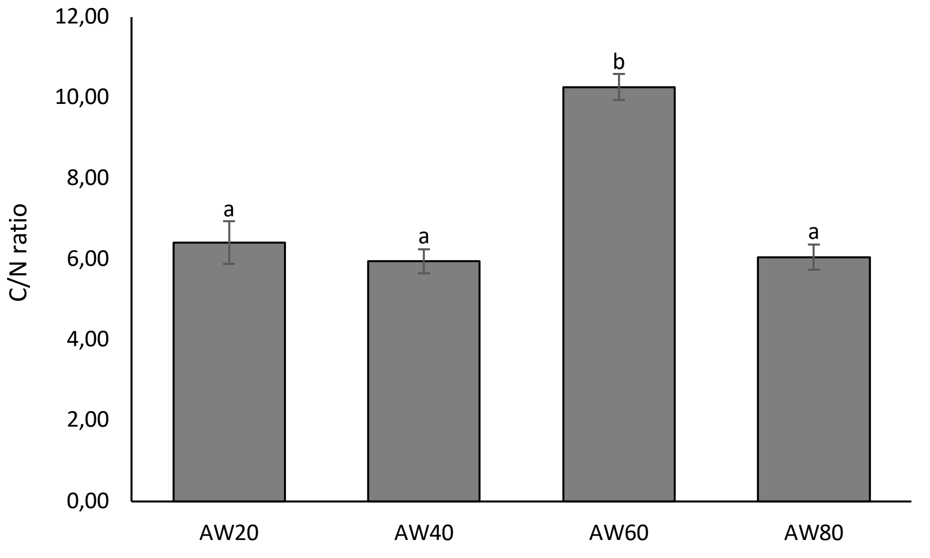

Figure 2. C/N ratio of liquid organic fertilizer with rumen waste. AW20: 20% rumen; AW40: 40% rumen; AW60: 60% rumen; AW80: 80% rumen. Different letters above the bar diagram indicate significant differences between treatments ($p \leq 0.05$).

Total phosphate

Phosphate content is one of the main parameters related to plant growth and development. Bhunia et al. (2019) stated phosphate can stimulate root growth and seed formation. Phosphate is often found in organic fertilizers because it supplies good nutrients for plants (Bhunia et al., 2021). Total phosphate content is generally correlated with other parameters, such as total nitrogen and total potassium, as a quality standard for the fertilizer produced.

Figure 3 shows that adding rumen with high concentrations (60% and 80%) can produce high total phosphate content in liquid organic fertilizer, 1.17% and 1.19%, respectively. This result was higher than in the treatment with the addition of 20% and 40% cow rumen ($p \leq 0.05$) (Figure 3). These findings indicate that rumen, initially used as waste, still contains relatively high levels of phosphate so that it can contribute to the high total phosphate in liquid organic fertilizer. In addition, rumen waste is thought to contain a high population of phosphate-degrading microbes, which also play a role in the high phosphate dissolution process and correlate with high total phosphate (Phibunwatthanawong & Riddech, 2019; Sureshkumar et al., 2013). This research uses additional rice washing water as a fertilizer mixture, which can contribute total phosphate to liquid organic fertilizer. As information, rice washing water contains 16.31% phosphate (Hamawi & Akhiriana, 2022).

The total phosphate results in Figure 3 are higher than the findings of other researchers. Previous research shows that liquid fertilizer contains total phosphate in 0.08-0.13% (Ngampimol & Kunathigan, 2008). Phibunwatthanawong & Riddech (2019) presented lower results, namely total phosphate of 0.015% in liquid organic fertilizer that had undergone 15 days of fermentation. A total phosphate content of 0.15% was also found in liquid fertilizer based on banana, mango, and pineapple peels, which were fermented for 7–14 days (Widyabudiningsih et al., 2021). In another study, the results of chemical analysis showed that fertilizer produced through the 30-day fermentation of kitchen waste contained a total of 0.015% phosphate (Hamawi & Akhiriana, 2022). In banana peel-based fertilizer, the total phosphate contained in it is 0.043% (Safuan et al., 2023). On the other hand, other researchers have revealed total phosphate above 2%, and liquid organic fertilizer made from pineapple skin contains a total phosphate of 2.4% (Susi et al., 2018). The existence of variability in materials, methods, and fermentation time strongly predicts differences in results between researchers regarding total phosphate content.

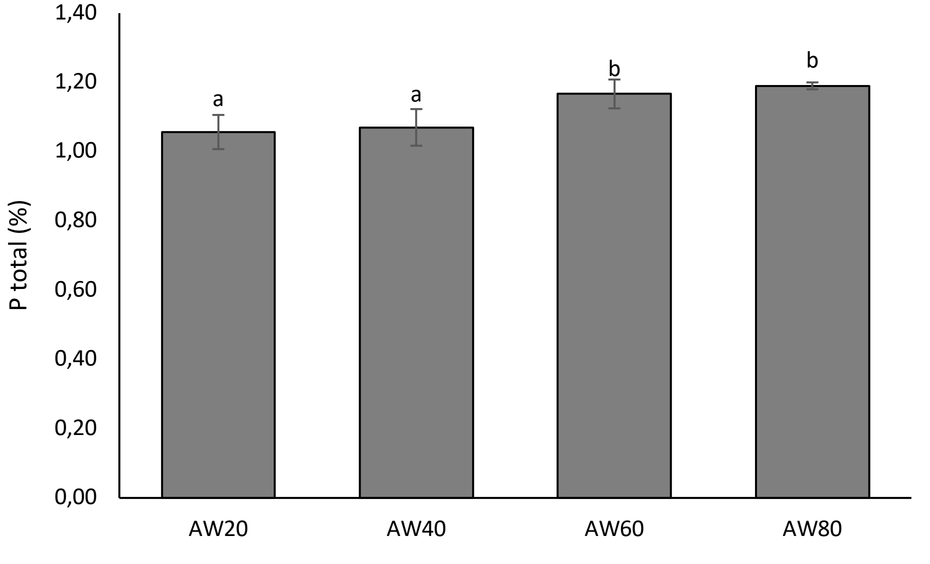

Figure 3. Phosphate total (P total) of liquid organic fertilizer with rumen waste. AW20: 20% rumen; AW40: 40% rumen; AW60: 60% rumen; AW80: 80% rumen. Different letters above the bar diagram indicate significant differences between treatments ($p \leq 0.05$).

Total potassium

Total potassium plays a vital role in plant growth and development. Potassium content, along with nitrogen and phosphate content, is one of the things to pay attention to when making organic fertilizer. Bhunia et al. (2021) explain that nitrogen, phosphate, and potassium are the primary nutrients in organic fertilizer. The three ingredients have specific roles. Namely, nitrogen accelerates cell growth and chlorophyll formation; phosphate stimulates root growth and seed formation; and potassium protects plants from drought and disease (Bhunia et al., 2019).

The research showed that the higher the addition of rumen, the higher the total potassium content in liquid organic fertilizer (Figure 4). When adding 80% of rumen, the total potassium obtained was 1.75%, the highest among other treatments ($p \leq 0.05$) (Figure 4). The trend in these results indicates that the rumen still contains significant potassium, so the additional concentration can significantly influence the total potassium from liquid organic fertilizer. The information in Figure 4 is a finding that can become the basis for further research regarding using rumen waste as fertilizer.

The results of this research are similar to the findings of Phibunwatthanawong & Riddech (2019), namely liquid organic fertilizer with a total potassium of 1.08%. This similarity is likely due to the similar fermentation time, namely 15 days. On the other hand, previous researchers found quite varied results regarding total potassium in liquid fertilizer. Susi et al. (2018) found that liquid organic fertilizer from pineapple peel contained 0.08% potassium. Meanwhile, fermenting banana, mango, and pineapple peels for 7–14 days can produce liquid organic fertilizer containing 2.5% total potassium (Widyabudiningsih et al., 2021). Recently, liquid organic fertilizer produced through 30 days of composting kitchen waste showed a total potassium of 0.1% in liquid fertilizer (Hamawi & Akhiriana, 2022).

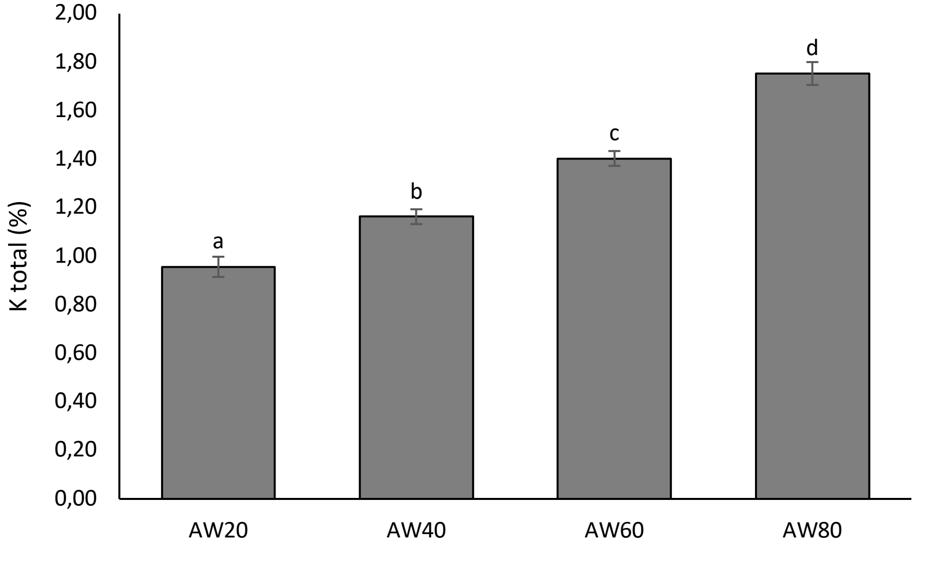

Figure 4. Potassium total (K total) of liquid organic fertilizer with rumen waste. AW20: 20% rumen; AW40: 40% rumen; AW60: 60% rumen; AW80: 80% rumen. Different letters above the bar diagram indicate significant differences between treatments ($p \leq 0.05$).

Total microbial

The presence of microbes in liquid organic fertilizer is essential and needs to be considered. Microbes contained in organic fertilizer can improve soil nutrients through nitrogen fixation and phosphorus metabolism (Nguyen et al., 2018). According to Ngampimol & Kunathigan (2008), several bacterial colonies from liquid fertilizer were found to be gram-positive bacteria. Furthermore, the role of microbes is also related to other factors, such as nutrient availability and environmental conditions, such as temperature, oxygen, pH, and humidity (Basmal et al., 2019). Therefore, the total microbial content was evaluated in this study.

Based on Table 1, the highest total microbes were in liquid organic fertilizer with the addition of 80% of the rumen, namely 5.5×10^{10} CFU/mL. This result exceeds the findings of other researchers, with the total number of microbes in liquid fertilizer ranging from 10^5-10^8 CFU/mL (Ngampimol & Kunathigan, 2008). Lower results were also presented by Basmal et al. (2019), who found that the total microbes contained in liquid fertilizer based on seaweed extract was 10^6 CFU/mL. Recent research examined liquid fertilizer based on sea crab waste and found results in total bacteria of 10^7 CFU/mL (Ramesh et al., 2020).The findings of this research indicate the high microbial content of rumen waste, which suggests its high potential for use as liquid organic fertilizer.

Table 1 also shows information regarding the physical characteristics of cow rumen-based liquid organic fertilizer. The same results were found in all treatments in this study: the color was bright and brown-yellowish, and the aroma was earthy. Hamawi & Akhiriana (2022) explained that a light yellowish-brown color is one of the physical indicators of liquid organic fertilizer. Other researchers also said that liquid organic fertilizer, which is yellowish brown with a liquid odor that is not strong, indicates the success of making fertilizer (Hamawi & Akhiriana, 2022). In terms of color and aroma, this research can produce liquid organic fertilizer with good characteristics.

Table 1. Microbial total and visual observation of liquid organic fertilizer with rumen waste

	Microbial total (cfu/mL)	Color	Aroma
AW20	5.2 x 10^{8}	bright, brown-yellowish	Earthy
AW40	4.1 x 10^{9}	bright, brown-yellowish	Earthy
AW60	1.1 x 10^{10}	bright, brown-yellowish	Earthy
AW80	5.5 x 10^{10}	bright, brown-yellowish	Earthy

AW20: 20% rumen; AW40: 40% rumen; AW60: 60% rumen; AW80: 80% rumen.

4. Conclusion

Rumen is produced as slaughterhouse waste. Rumen contains nutrients and beneficial microbes, so it has the potential as a mixture for making liquid organic fertilizer. Adding rumen with a high concentration (80%) can produce liquid organic fertilizer containing 2.35% nitrogen, a C/N ratio of 6.05, 1.19% phosphate, and 1.75% potassium. Adding 80% rumen, Liquid organic fertilizer had the highest total microbes among other treatments, namely 5.5 x 1010 CFU/mL, bright yellowish, and earthy aroma. The results of this research inform the high potential of rumen as a mixture for making good quality liquid organic fertilizer. Further research needs to be carried out regarding increasing rumen concentration to improve the quality of liquid organic fertilizer.

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