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# Fermentation of Cow Urine Collected from Ngabab Village, Malang: Its Potential as Liquid Fertilizer

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**Abstract.** The aims of this research is to analyze the quality of fermented cow urine, derived from Ngabab village, Pujon, Kab. Malang. The quality of fermented urine was determined from the concentrations of N, P, K, and ammonia (as  $\text{NH}_3$ ), using commercially available EM-4 and local microorganisms resulting from organic waste. The fermentation was conducted using 6 different ratios. They were: (1) urine: EM-4 = 2:1; (2) urine: EM-4 = 4:1; (3) urine: EM-4: organic waste = 4:1:1; (4) urine: table sugar: organic waste = 4:1:1; (5) urine: EM-4: table sugar = 10:5:1; and (6) urine only. Results showed that composition 1 resulted in the highest N content, while ratio 1 resulted in the highest P and K contents. Interestingly, the highest C organic achieved in the method 6, where urine fermented without any additives. In general, these results suggested that cow urine fermentation could be one of the green techniques to produce chemical fertilizer and pesticides which are environmentally harmful. Furthermore, the use of local microorganisms from organic waste can be considered as substitute for commercially available EM-4.

Keywords: cow urine, EM-4, fermentation, local microorganisms, liquid fertilizer

## 1. Introduction

The exploitative agriculture for centuries has resulted in the unproductiveness status of the soil to a level that even the application of fertilizers at higher rates is unable to sustain the productivity of soil [1]. Intensive use of chemicals offers an instantaneous effect on crop production for small term, but make long term harsh effects on both ecosystem and soil [2]. On one hand chemical fertilizers alone do not provide all the nutrients in balanced quantities needed by the plants; and on the other hand encourage depletion of soil organic matter content, adversely affect biological and physical properties of soil, also their increasing prices, and soil health deterioration. These have led to renewed interest in the use of organic fertilizers. The use of organic fertilizer not only helps to sustain crop yields but also plays a key role by exhibiting on the nutrient availability in soil by improving the physical, chemical and biological properties of soil [3-4].

Livestock is the oldest resources for mankind. With small holdings and small scale farming, there is no other better alternative than involving cattle in farming system. The abundant quantity of cattle excreta consisting of manure and urine is available at farm level. Though part of cattle dung is used as manure after decomposition process, cow urine usually drains out as waste material from farmer household [5]. Cattle urine is a good source of nitrogen, phosphate, potassium, calcium, magnesium,



chlorite and sulphate. It contains 95% water, 2.5% urea, 2.5% others (mineral salts, hormones and enzymes). Therefore, cow urine has a good fertilizer value and can be utilized as a bio fertilizer [5].

Ngabab village, is one of the villages in Pujon regency, Kabupaten Malang. This village produces the largest cow milk in the area. The majority of Ngabab villagers work as farmers and cow farmers. The Ngabab village produces about 11,000 L milk per day [6]. However, cow urine is also produced as waste from the cow farming. The cow urine has not been utilized yet. In addition, the cow urine is also polluting the environment. Therefore, this study is focused in the utilization of the cow urine collected from Ngabab village, and to transform it into something useful, *i.e.* liquid fertilizer, through fermentation process.

Fermentation represents an affordable and easy technique which will stabilize and retain the nutritional quality of the by-products. Recent development of using effective microorganisms (EM) in various sectors especially in waste treatments has urged this work to apply the use of EM-4 to ferment cow urine in order to transform it into liquid fertilizer. In recent years, EM technology has been commercialized and is easy to use [7]. Many research articles showed EM has been successfully used in composting, cleaning up polluted rivers and promote plant growth [8, 9]. Basically, EM contains LAB (lactic acid bacteria), yeast, actinomycetes, and photosynthetic bacteria [9]. It has been reported to be able to reduce foul smell in rubbish dumps, clean pollution, and initiates growth of plants [9-10]. In addition, local microorganisms that derived from organic waste are also applied for the fermentation process of cow urine. The organic waste is collected from farming waste, since the cow farmers in Ngabab village is also crop farmers.

## 2. Materials and Methods

### 2.1. Materials and Instruments

Materials used in this research included cow urine collected from cow farmers in Ngabab village, Pujon regency, Kabupaten Malang. Other materials were commercial effective microorganisms (EM-4), purchased from Tani Sejati shop, chemicals and reagents for determination of The N, P, K, total organic carbon, and ammonia contents ( $\text{NH}_3$ ) were purchased from Sigma-Aldrich or Merck. Instruments used were UV-Vis spectrophotometer (1601, Shimadzu) and atomic absorption spectrophotometer (AA-6200/Shimadzu).

### 2.2. Fermentation of Cow Urine

Approximately about 10 L of cow urine were obtained from cow farmers in Ngabab village. The fermentation of cow urine was conducted using 6 different compositions. They were: (1) 1 L urine:500 mL of EM-4; (2) 1 L urine:250 mL EM-4; (3) 1 L urine:250 mL EM-4:250 g organic waste; (4) 1 L urine: 250 g organic waste:250 g table sugar; (5) 1 L urine: 500 mL EM-4:100 g table sugar; and (6) 1 L urine (no addition). All cow urine used was undiluted. Fermentation was carried out for 30 days, aerobic condition, and in the dark room (with no direct contact with sunlight). At the end of the assay, fermented cow urine were filtered, and the filtrates were collected for further analysis. The N, P, K, total organic carbon, and ammonia contents ( $\text{NH}_3$ ) in the fermented cow urine were calculated. The N, P, and ammonia concentrations were determined using spectrophotometric method, while the organic carbon content was determined by volumetric method, and K concentration was analyzed using AAS method.

## 3. Results and Discussion

Most fertilizers that are commonly used in agriculture contain the three basic plant nutrients: nitrogen (N), phosphorus (P), and potassium (K). Therefore, in this study, the N, P, and K contents in the fermented cow urine were determined. Table 1 lists the N, P, and K, after fermentation process, using 6 different compositions.

Interestingly, there were no distinct trends in the N, P, K contents using varied fermentation compositions. The highest N contents was resulted from composition no 4, while the highest P and K was achieved in composition no 1. In composition 4, cow urine (1 L) was fermented with addition of

250 g of table sugar and 250 g of organic waste. The composition no 1 consisted of cow urine and EM-4 in 2:1 ratio (1 L urine:500 mL EM-4). These suggest that even though no EM-4 in the fermentation process, local microorganisms were able to decompose organic materials in the cow urine, and transform them into liquid manure that contain high nitrogen (N) content. The organic waste was collected from vegetables waste from Ngabab village as well.

**Table 1.** The N, P, and K concentrations in fermented cow urine

Composition	N (ppm)	P (ppm)	K (ppm)
1	8150.91 $\pm$ 6.7	14282.57 $\pm$ 7.5	71.88 $\pm$ 2.3
2	9315.32 $\pm$ 9.8	11531.54 $\pm$ 8.4	67.03 $\pm$ 4.6
3	7685.14 $\pm$ 11.2	10987.36 $\pm$ 8.9	67.39 $\pm$ 9.1
4	11178.39 $\pm$ 9.3	9886.85 $\pm$ 9.8	65.99 $\pm$ 10.4
5	9548.21 $\pm$ 8.9	13184.18 $\pm$ 12.3	19.74 $\pm$ 3.4
6	10013.97 $\pm$ 10.2	12083.44 $\pm$ 11.8	58.83 $\pm$ 6.8

\*The values are means and standard deviation of three replicates experiment

Other parameters determined were C/N ratio and ammonia concentration (Table 2). Results show that the highest C/N ratio was obtained from cow urine fermentation without any additive materials, as in composition 6. The maximum ammonia content was when cow urine fermented with sugar and organic waste (no EM-4, as in composition no 4). Again, this suggests that fermentation of cow urine is also effective with the use of local microorganisms.

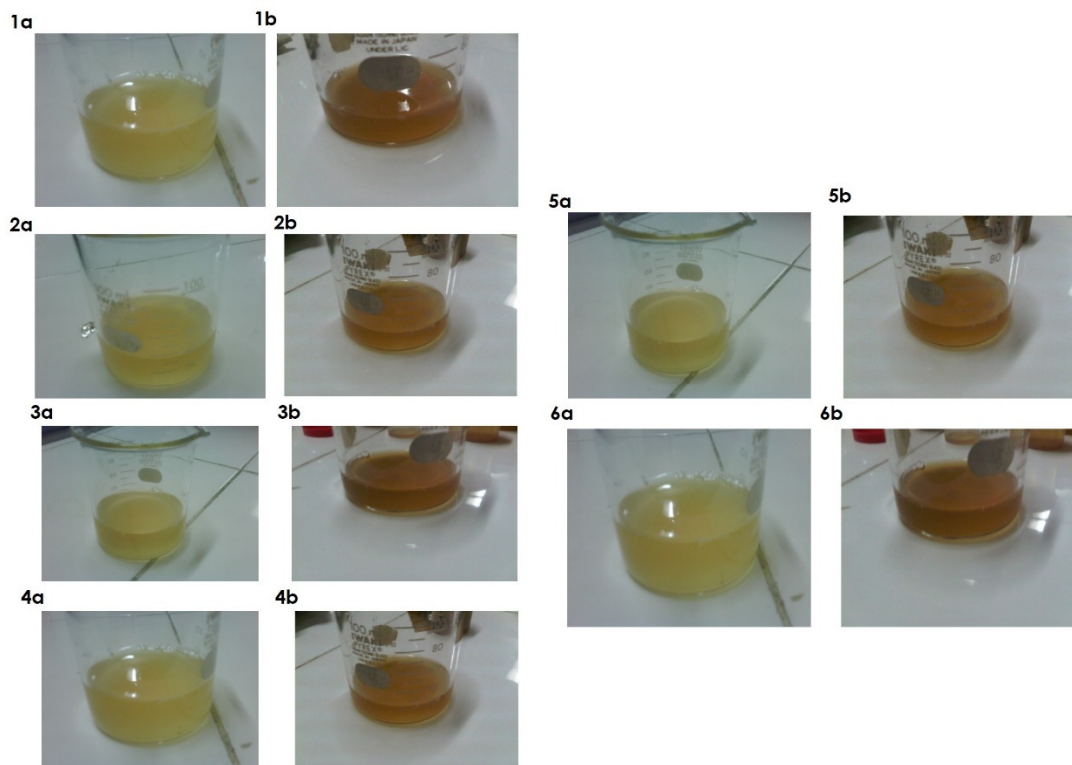
**Table 2.** The C/N ratio and ammonia (NH<sub>3</sub>) concentrations in fermented cow urine

Composition	C/N ratio	NH <sub>3</sub> (ppm)
1	1.15	3264
2	0.74	4441
3	1.11	2779
4	1.03	5207
5	0.84	4559
6	1.25	4144

\*The values are means and standard deviation of three replicates experiment

The physical appearance of fermented cow urine in the six different composition basically resulted in the similar types. The yellow distinct colour of cow urine turned into blackish solution of fermented cow urine (Figure 1). In addition, unpleasant cow urine odour was slightly decreased, after fermentation process.

The present study sought to shed more light on the efficacy in the waste management from cow farming activities in Ngabab village. The results have shown that, there are no particular compositions that resulted in the highest amounts of N, P, K C/N ratio, and total ammonium in the fermented cow urine. Therefore, particular composition is needed for the application of fermented cow urine for the liquid fertilizer. For instance, nitrogen is needed for plants as it vitals to chlorophyll, that allows plants to carry out photosynthesis [11], thus, to produce high quality of fertilizer with high N content, the composition no 4 should be applied. Phosphorus contributes to structural quality, seed production, and potassium is needed to plants characteristics, such as size, shape, or color [11]. For the requirement for high P and K, the fermentation should be conducted using ratio no 1. Meanwhile, the role of carbon in plants is to foster healthier and more productive growth of the plants [11]. This can be applied to use fermented cow urine without any addition.



**Figure 1** The physical appearance of the cow urine: (a) before fermentation; (b) after fermentation, fermentation process was conducted for 30 days, 1-6 are six different compositions (see methods section).

#### 4. Conclusion

The cow urine fermentation has been successfully conducted using six variabilities of ratios between urine, EM-4, and or/ table sugar and organic waste. The highest P and K contents in the fermented cow urine resulted from fermentation composition of 2:1 ratio of cow urine: EM-4. Interestingly, cow urine fermentation without EM-4 addition in the ratio of 4:1:1 ratio of cow urine:sugar:organic waste has the highest content of N and ammonia. Thus, the use of local microorganisms from organic waste should be taken into account for EM-4 substitution. Furthermore, fermentation of cow urine can be applied as one of the methods for organic waste management.

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