Potential of local organic matters in Jatinangor West Java Indonesia as raw materials for organic fertilizer

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Abstract. Jatinangor has a small area for the agricultural sector compared to other land uses. But for some villages in this district still, rely on agriculture and livestock sector. The main problems of this area include high land-use conversion that causes a decreasing level of soil fertility and decreasing of water availability. Furthermore, to fix this problem, organic matter application on soil or agricultural system is necessary. This study was aimed at mapping the availability and identify the properties of local organic matter in Jatinangor for supporting the sustainable farming system carried out by the farmers in Jatinangor. This research used qualitative, descriptive, comparative, and survey methods to explore the organic matter characteristics which must meet the standard of organic materials as fertilizer. Some sample of waste were taken based on purposive sampling method prior to nutrient, heavy metal, as well as acidity and organic carbon, has been analyzed. The results indicated that in Jatinangor District, there is no integrated household waste management and agricultural residues treatment. Furthermore, the potency of livestock residues still dominates as raw material for organic fertilizer. A total of 3683.65 kg/day animal waste might be used as organic matter for agriculture. There is an amount of macro and micronutrient, but their composition depended on livestock. Also, all animal waste contained heavy metal lower than the threshold. In general, animal waste from Jatinangor, West Java, Indonesia except duck waste might be used as organic fertilizer after composting to reduce the pH and organic C content.

1. Introduction

Agricultural sector is an important in Indonesia. This sector has a strategic role in national development, because it can increase the national income, providing employment, gaining added value and competitiveness. Also, for meeting domestic consumption needs, domestic industrial raw materials and optimizing sustainable management of natural resources. The agricultural systems will increase fertilizer needs. Fertilization is needed to replace nutrients lost from the soil due to the harvesting process, leaching, evaporation, or being bound by soil, so that nutrients are not available to plants [1,2,3]. One of the strategic way to improve national food security is to develop sustainable agricultural through improving land quality such as the application of local organic matter especially for small area.

Jatinanogor is one of densely populated city, with total area for agricultural land use is 42.98% but active use of agricultural land less than 20% [4]. In agricultural system, the use of organic materials is needed to reduce chemical residues in the soil. Main sources of organic matter in agricultural area such as animal waste, plantation residue, as well as residue from human activities. In Indonesia, referring to the statistical data, there is a 74% of organic waste is resulted [5]. This source can be used as raw material from organic fertilizer. On the other side, appropriate waste handling is needed to protect the environment, since organic waste can pollute the environment. But, the large quntity of organic waste
might be an important source for plant nutrient. According to [6], the number of leaf litter fell by 3-5% per tree influence the physical, chemical and biological properties of the soil. Organic matter also has the ability to increase soil holding capacity, soil aggregation, Cation Exchange Capacity (CEC) as well as nutrient and energy sources for microorganisms [7].

One of the organic matter that are widely available around the Jatinangor district is the waste from duck, sheep, cow and chicken farms [5]. According to [8], from one cow can produced as much as 27 kg of wet weight/tail/day. Nutrient composition in each animal waste is different depending on the amount and type of food. In general, nutrient content in animal manure is much lower than chemical fertilizers, so higher dose is needed. However, the nutrient in animal waste is slow available but not easy to be leach out from roots zone. The availability of nutrients is greatly influenced by the level of decomposition and mineralization of these materials. The low availability of nutrients from manure is partly due to the form of N, P and other elements found in the form of complex organo-protein compounds or lignin that are difficult to decompose. A lot of local organic matter, mainly animal waste, is produced every day in Jatinangor but the information of the waste quality is very limited. The objective of this study was to mapping the availability and identify the properties of local animal waste in Jatinangor to support the sustainable farming system carried out by the farmers in Jatinangor.

2. Material and Methods
The study was conducted with qualitative, descriptive, comparative and survey methods. The survey is carried out by a physiographic and database approach in the 12 villages in Jatinangor districts that have a big potency for organic material source. Every village recorded for data needed such as agriculture area, land use map, and livestock area in villages that will give information about the source of local organic matter. Analysis of organic waste properties (chemistry) was conducted at the Laboratory of Soil Chemistry and Plant Nutrition. Analysis of some chemical properties include macronutrients, micronutrients, heavy metals, acidity and organic carbon were carried out in the laboratory by using standard method for 33 samples. The samples taken are grouped according to the range of age waste in the field. Mapping analysis was conducted at the Land Evaluation Laboratory of the Department of Soil Science, Universitas Padjadjaran.

3. Result and Discussion
In general, the potency of organic matter in Jatinangor district is a lot, but the farmers do not yet use it optimally as agricultural input. Based on our previous study, active land use for agriculture in Jatinangor is small [5], so the organic waste might fulfill the demand of organic matter for food crops production. Furthermore, based on a survey that has been done, the big source of organic matter in Jatinangor District as main source of organic waste (Table 1).
Table 1. Amount of Animal Waste in Jatinangor District, Sumedang Regency

| Sample | Livestock | Owners   | Amount of Animals | Feeds                       | Villages | Productio of Waste (kg/day) |
|--------|-----------|----------|-------------------|-----------------------------|----------|-----------------------------|
| 1      | Cow       | Darwat   | 5                 | grass, cassava and bran     | Jatiroke | 50                          |
| 2      | Sheep     | Saepudin | 15                | Grass                       | Jatiroke | 21                          |
| 3      | Sheep     | Herman   | 19                | grass, tofu dregs           | Jatiroke | 26.6                        |
| 4      | Cow       | Darwat   | 18                | Grass                       | Jatiroke | 180                         |
| 5      | Sheep     | Bidin    | 2                 | Grass                       | Jatimukti| 2.8                         |
| 6      | Duck      | Caca     | 60                | concentrate, bran and snail| Jatimukti| 84                          |
| 7      | Duck      | Samsudin | 60                | concentrate, bran and snail| Jatimukti| 84                          |
| 8      | Sheep     | Borna    | 3                 | Grass                       | Cisempur | 4.2                         |
| 9      | Sheep     | -        | 10                | Grass                       | Cisempur | 14                          |
| 10     | Sheep     | Sadang   | 3                 | Grass                       | Cisempur | 12.6                        |
| 11     | Broiler   | Kanarji  | 14000             | cam food straw              | Cileles  | 2100                        |
| 12     | Cow       | Martin   | 6                 | grass, cassava and bran     | Cileles  | 220                         |
| 13     | Cow       | Epit     | -                 | Grass                       | Cilayung | -                           |
| 14     | Cow       | Diding   | 4                 | Grass                       | Cilayung | 40                          |
| 15     | Sheep     | Ajat     | -                 | Grass                       | Cilayung | -                           |
| 16     | Cow       | Ayi      | 5                 | Grass                       | Cilayung | 50                          |
| 17     | Cow       | Oleh     | 25                | straw, tofu dregs, grass    | Cilayung | 25                          |
| 18     | Cow       | Nana     | 40                | and concentrate             | Cilayung | 400                         |
| 19     | Cow       | -        | -                 | -                           | Cilayung | -                           |
| 20     | Cow       | Oyo      | 8                 | Straw                       | Cilayung | 80                          |
| 21     | Cow       | Eka      | 9                 | tofu dregs and bran         | Cikeruh  | 90                          |
| 22     | Cow       | Mumun    | 6                 | tofu dregs and grass        | Hegarmanah| 60                          |
| 23     | Cow       | Odi      | 2                 | Straw and grass             | Hegarmanah| 20                          |
| 24     | Cow       | Awan     | 2                 | tofu dregs and grass        | Hegarmanah| 20                          |
| 25     | Sheep     | Edi      | 9                 | Grass                       | Cipacing | 12.6                        |
| 26     | Sheep     | Ajun     | 11                | Grass                       | Cipacing | 15.4                        |
| 27     | Sheep     | Bandi    | 40                | Grass                       | Sayang   | 56                          |
| Sample | Livestock | Owners | Amount of Animals | Feeds | Villages  | Production of Waste (kg/day) |
|--------|-----------|--------|-------------------|-------|-----------|-----------------------------|
| 28     | Sheep     | Amir   | 6                 | Grass | Sayang    | 8.4                         |
| 29     | Sheep     | Odih   | 60                | tofu dregs, cassava leaf and grass | Sayang | 84                     |
| 30     | Sheep     | Sabda  | 7                 | Grass | Mekargalih | 9.8                         |
| 31     | Sheep     | Aep    | 3                 | Grass | Mekargalih | 4.2                         |
| 32     | Duck      | Iwan   | 95                | tofu dregs, snail, fish | Mekargalih | 14.25                     |
| 33     | Cow       | Tatang | 6                 | Straw and tofu dregs | Mekargalih | 60                         |

Source: Field Survey, 2018.

Average of cow waste production (10 kg/animal); average of sheep waste production (1.4 kg/animal); average of chicken and duck waste production (0.15 kg/animal)

Based on the previous data, we will categorize the animal waste which depend on the same properties including macronutrients and micronutrients as well as heavy metals. All chemical properties are a general indicators of raw organic matter quality [10] that will be utilized as organic fertilizer in the farms. Mapping of various local organic matters from animal waste in Jatinangor was depicted in Fig. 1 above.

![Figure 1. Map of Livestock in Jatinangor, District](image-url)
From a map of livestock above, we can see that in Jatinangor District, residue from livestock can produce raw material of organic fertilizer for that area. The average of animal waste that resulted in Jatinangor District per day illustrated below (Graph.1).

**Graphic 1. Average of Animal Waste**

### 3.1 Macro Nutrient Elements (N, P, K, Ca, Mg, S)
Laboratory analysis showed that macronutrient content of various animal waste taken from Jatinangor District was vary (Table 2).

| No | Waste                                      | Macronutrients |
|----|--------------------------------------------|----------------|
|    |                                            | N (%) | P (%) | K (%) | Ca (%) | Mg (%) | SO₄ (%) |
| 1  | Duck Waste (4 weeks)                       | 4.72  | 6.74  | 0.83  | 7.65   | 0.38   | 0.05    |
| 2  | Chicken Waste (2 weeks)                    | 2.74  | 1.59  | 0.86  | 1.88   | 0.53   | 0.04    |
| 3  | Chicken Waste (4 weeks)                    | 3.06  | 1.34  | 0.87  | 1.22   | 0.42   | 0.04    |
| 4  | Cow Waste (0 weeks)                        | 1.51  | 0.52  | 0.70  | 1.84   | 0.75   | 0.03    |
| 5  | Cow Waste (2 weeks)                        | 1.87  | 0.52  | 0.79  | 2.04   | 0.72   | 0.04    |
| 6  | Cow Waste (4 weeks)                        | 1.37  | 0.39  | 0.18  | 1.87   | 0.57   | 0.03    |
| 7  | Cow Waste (8 weeks)                        | 1.45  | 0.40  | 0.24  | 1.72   | 0.93   | 0.04    |
| 8  | Cow Waste (12 weeks)                       | 1.46  | 0.51  | 0.26  | 1.99   | 0.98   | 0.04    |
| 9  | Sheep Waste (0 weeks)                       | 2.20  | 0.88  | 0.48  | 1.10   | 1.33   | 0.04    |
| 10 | Sheep Waste (2 weeks)                       | 2.28  | 1.43  | 0.52  | 2.13   | 1.94   | 0.04    |
| 11 | Sheep Waste (8 weeks)                       | 2.30  | 2.08  | 2.69  | 2.49   | 2.11   | 0.04    |

Duck waste and chicken waste have a higher number of macronutrients compared to other animal waste. The higher N and P concentration showed by duck waste since duck feeds are mainly concentrated, bran and snail which contain a significant amount of N and P. Otherwise, chicken manure has more nitrogen than other manures, whereas sheep manure contains N and K which is greater than cow manure. Lowest macronutrients in cow manure were caused by the poor quality of feed; usually, farmers only feed cows with grass. This is in line with [1] that the concentration of nitrogen is influenced by types of manure which refers to feed of animal and physiological characteristics. Thus, animal waste can supply the nutrients for a plant by the decomposition process. Chicken and duck waste were easy to decompose compared to other types of waste at the same age [9]. Animal waste amendment into the soil as well as planting media, can deliver nutrients for plant growth and improve physical, chemical and biological properties. The results of this study are in line with [9] who showed that manure made from animal waste have nutrients for plants growth.
3.2 Micronutrients
Analysis of micronutrient from animal waste is important to verify the level of essential microelement for plant growth and production. Micronutrient content in animal waste was depend on the kind of livestock and the age of waste (Table 3).

| No | Samples          | Fe (mg/kg) | Mn (mg/kg) | Cu (mg/kg) | Zn (mg/kg) | B (mg/kg) |
|----|------------------|------------|------------|------------|------------|-----------|
| 1  | Duck Waste (4 weeks) | 26618.80   | 400.12     | 37.33      | 159.86     | 183.21    |
| 2  | Chicken Waste (2 weeks) | 1036.48    | 430.95     | 27.21      | 207.12     | 83.12     |
| 3  | Chicken Waste (4 weeks) | 554.82     | 619.86     | 295.80     | 220.15     | 116.11    |
| 4  | Cow Waste (0 weeks) | 1252.13    | 426.69     | 11.09      | 51.45      | 72.22     |
| 5  | Cow Waste (2 weeks) | 1507.69    | 395.86     | 16.20      | 57.53      | 107.09    |
| 6  | Cow Waste (4 weeks) | 2051.51    | 302.40     | 8.48       | 40.59      | 83.22     |
| 7  | Cow Waste (8 weeks) | 1143.27    | 99.45      | 8.43       | 40.55      | 55.00     |
| 8  | Cow Waste (12 weeks) | 1268.03    | 253.56     | 8.75       | 47.25      | 86.65     |
| 9  | Sheep Waste (0 weeks) | 2355.05    | 676.23     | 25.48      | 102.33     | 100.85    |
| 10 | Sheep Waste (2 weeks) | 2751.53    | 726.16     | 26.23      | 130.09     | 141.45    |
| 11 | Sheep Waste (8 weeks) | 4385.81    | 789.50     | 35.67      | 143.70     | 221.91    |

The decomposition process of poultry waste is faster than other animal wastes, followed by sheep waste and cow waste. Furthermore, the animal waste that mixed with urine has more content of nutrients. This condition is because in livestock urine can be found in large quantities of high organic matter and N content generally more than 70% of nitrogen [9,10]. According to agricultural regulations of organic fertilizer standards that can be used in agricultural systems [10], the micronutrients from animal wastes above still intolerance limit, but no for duck waste. The limit content of micronutrients in solid organic material for Fe (maximum is 9000 mg/kg), Zn and Mn (maximum is 5000 mg/kg). According to [12] in a higher concentration of zink can cause a phytotoxic, caused by the early assimilated process by the plant.

3.3 Heavy Metal Analysis
The content of toxic heavy metals cadmium, nickel, chromium, lead and cobalt in animal waste taken from Jatinangor area is vary (Table 4).

Generally, all heavy metals content in animal waste above is low, below the concentration of heavy metals [10]. We can see when the age of duck waste is for weeks, the heavy metals have a higher compared to other animal waste, especially for Pb with the content more than 10 mg/kg. However, this number is still below from the specified threshold. In [13,14] state that feed additive and animal medicines can cause the environmental problem by animal waste. The average of heavy metals contents in poultry and livestock feed for duck are Cd (0.51 mg/kg); Pb (6.64 mg/kg); Cr (12.50 mg/kg); Ni (2.36 mg/kg); Co (0.46 g/kg). This content can supply the heavy metals content on animal waste from that animal. The chicken waste also has a content of a high amount of heavy metal concentration after duck waste, followed by sheep and cow waste.
Table 4. Heavy Metals Content in Animal Wastes of Jatinangor

| No | Samples                  | Cd (mg/kg) | Ni (mg/kg) | Cr (mg/kg) | Pb (mg/kg) | Co (mg/kg) |
|----|--------------------------|------------|------------|------------|------------|------------|
| 1  | Duck Waste (4 weeks)     | 0.13       | 7.46       | 14.06      | 10.87      | 3.35       |
| 2  | Chicken Waste (2 weeks)  | nd*        | 7.17       | 10.06      | 6.14       | 1.05       |
| 3  | Chicken Waste (4 weeks)  | nd*        | 6.31       | 7.67       | 6.29       | 1.02       |
| 4  | Cow Waste (0 weeks)      | 0.02       | 2.85       | 5.77       | 4.01       | 0.93       |
| 5  | Cow Waste (2 weeks)      | 0.03       | 3.39       | 6.74       | 5.07       | 0.99       |
| 6  | Cow Waste (4 weeks)      | 0.02       | 2.85       | 6.64       | 3.45       | 0.90       |
| 7  | Cow Waste (8 weeks)      | 0.04       | 2.65       | 5.27       | 4.35       | 0.88       |
| 8  | Cow Waste (12 weeks)     | 0.01       | 2.59       | 5.64       | 3.67       | 0.83       |
| 9  | Sheep Waste (0 weeks)    | 0.00       | 3.53       | 7.72       | 6.06       | 2.14       |
| 10 | Sheep Waste (2 weeks)    | nd*        | 3.76       | 8.39       | 6.46       | 2.30       |
| 11 | Sheep Waste (8 weeks)    | 0.02       | 5.15       | 11.82      | 8.46       | 3.40       |

nd*: not detectable, below the detectable limit

The age of waste affects the availability of heavy metals because the shape of animal waste will affect the decomposition process. If animal manure applied to the soil, the heavy metal would be released to the soil and uptake by plant roots. Heavy metals have no function in plant metabolisms; contamination of heavy metal in soil induce plant toxicity. Furthermore, the accumulation of heavy metal in the edible part of food crops harm human health [16]. Heavy metal enters the ground through several processes such as the application of animal waste or chemical fertilizers [15,16,17]. Application of heavy metals in the soil was influenced by the application method, nature and type of manure [15].

3.4 Organic Carbon and Acidity
In general, animal wastes reaction was slightly alkaline to alkaline; higher pH was demonstrated by eight week-old sheep waste and the lower one was in duck waste. On the other side, organic-C content of all animal wastes was very high irrespective of animal species and incubation time (Table 5).

Table 5. Acidity, Organic Carbon, and C/N ratio on Animal Wastes in Jatinangor

| No | Samples                  | pH  | Organic C (%) | C/N |
|----|--------------------------|-----|--------------|-----|
| 1  | Duck Waste (4 weeks)     | 7.59| 37.23        | 8   |
| 2  | Chicken Waste (2 weeks)  | 7.58| 45.55        | 17  |
| 3  | Chicken Waste (4 weeks)  | 8.55| 47.54        | 16  |
| 4  | Cow Waste (0 weeks)      | 8.73| 35.97        | 24  |
| 5  | Cow Waste (2 weeks)      | 8.55| 37.71        | 20  |
| 6  | Cow Waste (4 weeks)      | 7.89| 38.51        | 28  |
| 7  | Cow Waste (8 weeks)      | 7.97| 37.65        | 26  |
| 8  | Cow Waste (12 weeks)     | 7.97| 38.29        | 26  |
| 9  | Sheep Waste (0 weeks)    | 8.36| 41.47        | 18  |
| 10 | Sheep Waste (2 weeks)    | 8.64| 47.95        | 24  |
| 11 | Sheep Waste (8 weeks)    | 9.45| 36.58        | 16  |
Since the pH was alkaline and organic content was too high, the application of fresh animal waste directly to the agricultural soil can cause some problem. Waste with high organic C content and high fibre content such as cellulose, hemicellulose and even lignin can increase the carbon and nitrogen ratio (C/N). In [18], a high C/N ratio will cause the availability of energy for soil organisms to grow rapidly. When nitrogen was not available for roots uptake, the vegetative growth will be disturbed. In this situation, competition between plants and soil microbes was taken place in sorption the nutrients from the soil. On the other side, from the database above, the lower C/N ratio from various animal waste is from duck waste. This condition is because animal waste is already decomposed. This is in line with [19,20] that the mineralization process is increasing when N content is high and low C/N ratio in soil organic matter. This is correlated with a result of other nutrients contained in duck waste is bigger than others (Table.2, Table.3 and Table.4)/

4. Conclusions
In Jatinangor District, has a potency of raw organic matter from animal waste. Animal waste excreted form cow (1295 kg/day), chicken (2100 kg/day), sheep (106.4 kg/day) and duck (182.25 kg/day). The average of nutrients content in animal wastes were N (1.37-4.72%), P (0.34-6.74%), K (0.18-2.69%), Ca (1.10-7.65%), Mg (0.38-2.11%), SO₄ (0.03-0.05%), Fe (554.82-26618.80 ppm), Mn (99.45-787 ppm), Cu (8.43-295.80 mg/kg), Zn (40.25-220.15 mg/kg) and B(55-221.91 mg/kg). Animal waste contain heavy metals Cd, Cr, Pb and Ni below the threshold concentration based on Indonesian Regulation. The reaction of animal manure is slightly alkaline to alkaline (7.59-9.45) and its organic C content was high (35-97-47.95%). In general, animal waste from Jatinangor, West Java, Indonesia except duck waste might be used as organic fertilizer after composting to reduce the pH and organic C content.

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