Effect of ashing temperature on potassium nutrient content of various organic matter

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Abstract. Mineral ash fertilizer resulting from a burning process of plant wastes has the potential to replace or reduce the use of inorganic potassium fertilizers. Hence it can increase the availability of potassium for plants. This study aimed to determine the effect of ashing temperature on potassium nutrient content from kapok peels, banana stems, and coconut husks. The combustion temperature treatments were 300°C and 600°C for 3 hours into the muffle furnace and without ashing. Analysis of potassium content was conducted using the Atomic Absorption Spectrophotometer (AAS) method. The results showed that the temperature of 600°C gave the highest content of potassium from kapok peel (9.59%), the temperature of 300°C for banana stem (9.82%), while without ashing, the highest content of potassium was from the banana stem (8.20%). The organic matter that produces the highest potassium content was banana stem at an ashing temperature of 300°C, and the lowest was coconut husk at an ashing temperature of 600°C.

1. Introduction
Potassium (K) is an essential nutrient needed by plants so that its function in plants cannot be replaced by other elements [1]. Potassium plays a role in the starch formation, activates enzymes, opens stomata (regulates respiration and evaporation), physiological processes in plants, metabolic processes in cells, affects the absorption of other elements, increases resistance to drought, diseases besides that, it also plays a role in root development [2].

Potassium in the soil available to plants is only 2-10%, while about 90 to 98% of the total potassium is in the form that is not readily available so that it cannot be absorbed by plants [3]. The low content of potassium in the form available in the soil causes low absorption of potassium by plants which have an impact on the growth and quality of crop yields, so farmers use inorganic potassium fertilizers to increase the levels of potassium available in the soil. The use of inorganic potassium fertilizers encountered problems because the fertilizers were imported from abroad, so that the price of fertilizers was high. This encourages farmers to look for alternative sources of fertilizer, one of which is plant waste.
Fertilizers from mineral ash resulting from burning plant waste have the potential to replace or reduce the use of inorganic potassium fertilizers so as to increase the availability of potassium for plants. Administration of organic potassium will increase the process of photosynthesis and transport of photosynthetic products (assimilate) from the leaves to the phloem to reproductive and storage tissues [1].

Several types of plant ash that can be used as organic sources of potassium include coconut husk, kapok peels, and banana stem. Coconut husks ash contains 0.03% N total, 2.31% P total, 21.87% K total, 0.01 C organic, pH of 11.77, and the value of cation exchange capacity of 13.29 me/100 grams, and when ashing conducted on coconut husks, the ash can contain 20-30% potassium and 2% phosphorus [4,5]. Making banana stem ashes using a muffle furnace at a burning temperature of 550°C for 3 hours contains 36.19% potassium 33.4% potassium [6,7]. The ash of the kapok fruit peel by burning for 3 hours and a temperature of 500°C analyzed by Atomic Absorption Spectroscopy gave the K₂O content of 35.91% [8].

Based on the description above, this study aimed to determine the effect of differences in combustion temperature on the nutrient content of potassium ash from plant waste.

2. Methodology

2.1. Tools and materials
The tools used in this research were analytical balance, measuring flask, test tube, tube shaker, porcelain cup, stirring rod, dropper, oven, Atomic absorption spectrophotometer (AAS), muffle furnace. Materials used in this study were samples of coconut husk, banana stem, and kapok peels, aquabidest, HNO₃, HClO₄.

2.2. Research procedures
2.2.1. Determination of moisture content. A clean cup along with the lid was heated in the oven for 3 hours. Then the cup was closed and cooled in a desiccator for 15 minutes. Subsequently, the cup was weighed as empty weight. Sample of kapok fruit peels, banana stems, and coconut husk was weighed as much as 5 grams, respectively, then placed in the cup and weighed with the lid. The samples were heated in an oven at 105°C for 3 hours, then cooled in a desiccator and weighed again. The water content was calculated using the following equation:

\[
\text{Moisture content (\%) } = \frac{\text{weight loss}}{\text{original sample weight}} \times 100 \quad [9]
\]

2.2.2. Determination of ash content. The determination of the ash content was carried out in the following steps: cutting the samples of kapok fruit peels, coconut husk, and banana stems into small sizes, evaporated in an oven at 105°C for 3 hours. Each sample was weighed 5 grams and placed into a muffle furnace for combustion at a temperature of 300°C and 600°C for 3 hours. The result from combustion was placed in a desiccator for the cooling process then weighed to determine the weight of the ash. The ash content can be calculated using the formula:

\[
\text{Ash content (\%) } = \frac{W2}{W1} \times fk \times 100
\]

\[
W2 = \text{Weight of ash in grams}
\]
\[
W1 = \text{Sample weight in grams}
\]
\[
fk = \text{Moisture content correction factor } = \frac{100}{(100- \% \text{ moisture content})} \quad [9].
\]

2.2.3. Determination of potassium nutrient content. Determination of the potassium nutrient content was conducted using the Atomic Absorption Spectrophotometer (AAS) method. Ashes from the kapok peel, coconut husk, banana stems, and without ashes were added with 0.5 ml of 4 p.a HClO₄ and 5 ml of HNO₃ p.a, then heated on a hot plate until the ash dissolved, subsequently diluted with ion-free
water to 50 ml then shaken until homogeneous. As much as 1 ml of the extract and standard K series were pipetted each into the chemical tube and added 9 ml of 0.25% La solution. The solution was shaken using a tube shaker until homogeneous. Potassium content for each sample was measured with a standard series of potassium as a comparison. The absorbance of each sample was measured at a wavelength of 766.5 nm [9].

3. Results and discussion

3.1. Moisture content of the organic materials

The moisture content of coconut husk, banana stem, and kapok peels was shown in table 1.

| Organic materials | Water content (%) |
|-------------------|-------------------|
| Coconut husks     | 8.3               |
| Banana stems      | 5                 |
| Kapok peels       | 8.2               |

Water content is the amount of water contained in the material, which is expressed in percent. Table 1 indicated that the highest water content was in coconut husk of 8.3%, followed by kapok peels of 8.2%, and the lowest was in banana stems with a water content of 5%.

3.2. Effect of combustion temperature (°C) on ash content of organic materials (%)

The ash content of coconut husks, banana stems, and kapok peels resulted from different combustion temperatures was shown in table 2.

| Organic materials | Without ashing | Ash content (%) |
|-------------------|----------------|-----------------|
|                   |                | 300°C           | 600°C           |
| Coconut husks     | -              | 58.00           | 6.00            |
| Banana stems      | -              | 54.00           | 23.00           |
| Kapok peels       | -              | 54.90           | 8.00            |

The content and composition of the ash in the organic material depends on the type of material and the method of ashing. The ash content of a material indicates the mineral content in the material. Table 2 showed that the ash content of the kapok peels at the combustion temperature of 300°C is 54.90% and at a temperature of 600°C decreased by 8%. Similarly, the ash from banana stems at the combustion temperature of 300°C was 58.0% and increasing the temperature to 600°C decreased the ash content to 23%, the ash of the coconut husk at the combustion temperature of 300°C was 58.00% and at a temperature of 600°C it decreased by 6%. Based on these data, it can be seen that the increase in combustion temperature resulted in decreased ash content. The low ash content at higher combustion temperature was attributed to increased reaction between carbon and water vapor with increasing combustion temperature. Hence the carbon that reacts turned into CO₂ and resulted in a lot of H₂O. On the other hand, the amount of ash produced was getting smaller [10]. The results of this study were consistent with research conducted by Tirono and Ali (2011), on coconut husks burning, where an increase in temperature resulting in lower ash content [11].

3.3. Effect of combustion temperature (°C) on potassium nutrient content (%)

Table 3 showed the effect of combustion temperature on the potassium content in the ash produced. Potassium content in the kapok peels in the control treatment (without ashing) was 3.67%, while kapok peels at 300°C of combustion temperature contained 5.53% potassium and increased to 9.59%
at combustion temperature of 600°C. The results from the kapok peels indicated that the higher the combustion temperature used would increase the potassium level. The influence of combustion on banana stems show a slight increase in potassium levels, where the potassium in the materials without combustion was 8.20%, use of combustion temperature of 300°C resulted in 9.82% of potassium content, while combustion temperature of 600°C showed potassium content of 9.19%. Coconut husks without combustion contained 2.73% potassium, while the combustion temperature of 300°C increased the potassium content by 6.50%, then at the combustion temperature of 600°C resulted in decreased potassium content by 1.09%. Decreased potassium levels can occur as other alkaline components increase in number as temperature increases [12].

**Table 3.** Potassium nutrient content (%) with variations in combustion temperature.

| Organic materials | Potassium content (%) | Without ashing | 300°C | 600°C |
|-------------------|-----------------------|----------------|-------|-------|
| Coconut husks     |                       | 2.73           | 6.50  | 1.09  |
| Banana stems      |                       | 8.20           | 9.82  | 9.10  |
| Kapok peels       |                       | 3.67           | 5.53  | 9.59  |

4. Conclusions
The best temperature for the highest percentage of potassium content in kapok peels of 9.59% (23.1% K₂O) was 600°C. The temperature of 300°C in the ashing of banana stems and coconut husks produced the highest percentage of potassium of 9.82% (23.67% K₂O) and 6.50% (15.66% K₂O), respectively. The organic material that produces the highest percentage of potassium was the banana stem with a combustion temperature of 300°C.

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