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PREPARATION OF GRANULAR POTASSIUM FERTILIZER FROM ASH OF BURNING OIL PALM EMPTY FRUIT BUNCHES

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ABSTRACT

This study aims to develop a method of making granular potassium fertilizer based on TKKS ash. The manufacturing process involves TKKS ash characterization, material processing, formulation, and granulation stages. The main parameters analyzed include potassium (K_2O) content and the effectiveness of the fertilizer in improving plant growth. The results showed that TKKS ash contains high potassium levels that can be processed into granular fertilizer with physical and chemical qualities that meet the standards. The granulation process produces fertilizer with good granule strength, Application tests on plants show a significant increase in growth parameters compared to the control. TKKS ash can be used as a raw material for the production of granular potassium fertilizers that are effective and environmentally friendly. This research provides a solution for biomass waste management and supports sustainable agricultural practices.

Keywords: Oil Palm Empty Bunch Ash, Granular Potassium Fertilizer, Biomass Waste, Granulation, Sustainable Agriculture.

INTRODUCTION

Fertilizer is a material that contains a number of nutrients necessary for plants. Fertilization is an effort to provide nutrients to plants to support their survival. Fertilizers can be made from organic or inorganic materials. Giving fertilizer needs to pay attention to the dose needed by plants, do not let the fertilizer used less or more than the dose which will ultimately interfere with the growth and development of plants. Fertilizers can be given through plants or sprayed to the leaves of the problems that arise are the large number of empty oil palm bunches produced by palm oil mills, namely 22% to 25% of the processed FFB, on the basis of which the idea arose to maximize the utilization of waste by converting the ash of empty oil

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palm bunches into granular fertilizers that have economic value (Rahmad, F., & Kusuma, 2020).

Plants need 13 kinds of essential macro nutrients (N, P, K, S, Mg, Ca), micro nutrients (Cl, Fe, Mn, Zn, Cu, B, Mo) and approximately 5 non-essential/functional nutrients (Na, Co, V, Si, Ni). The 13 essential nutrients are required by plants for proper metabolism, while the 5 non-essential nutrients, in some cases, are able to function or temporarily replace the role of some essential nutrients. Lack of just one of the essential nutrients will lead to limited productivity. In terms of nutrients, plant productivity is limited by the most minimal nutrients (Lingga, P., & Marsono, H. 2017).

Burnt ash of oil palm empty fruit bunches has various benefits as fertilizer, including increasing the element potassium (K) which plays a role in the photosynthesis process, plant resistance to disease, and strengthening plant cell walls. In addition, its alkaline nature can help raise the pH of acidic soil, thereby increasing its fertility. The ash also contains calcium and magnesium, which are important for root growth and the formation of healthy plant tissues, and contributes to improving soil structure by improving drainage and aeration. However, the use of ash needs to be done wisely as the very high content of elements such as potassium and calcium can cause nutrient imbalances if applied in excess. For optimal results, ash should be mixed with other organic materials to maintain soil fertility in a sustainable manner.

The use of Palm Oil Empty Bunch combustion ash in making granular fertilizer is also in line with the principles of sustainable development. The utilization of agricultural waste not only reduces the negative impact on the environment, but also creates products that have economic value, thus providing benefits for farmers and the palm oil processing industry (Siregar, S., & Santoso, B. 2021).

Based on the above background, this research wants to study: What is the effect of nettle ash weight on granular fertilizer characteristics. What is the effect of adhesive weight on the characteristics of granular fertilizer.

Table 1 Nutrient Content of Oil Palm Empty Bunch Burnt Ash.

No	Element	Contents (%)
1	K2O	41.18%
2	Moisture	1.15%

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Table 2 Quality Requirements for Solid Organic Fertilizer.

No	Uraian	Unit	Condition
1	Follow - up materials (Beling / broken glass , plastic and / or metal)	%	Max 2
2	Kadar Water	%	8 – 25
3	C – Organic	%	Min.15
4	C/N		M a ks.25
5	pH		4 – 9
6	Hara makro (N + P 2 O 5 + K2O	%	Min.2
	- Fe total	ppm	Price : 15,000
	- Fe Available	ppm	Max 1,000
	- Zn total	ppm	Price 5,000
8	Size Butiran (2 – 4, 7 5)mm	%	Min.60

METHOD

1. Tools And Material

The tools used in this research include a weighing scale, a tool for mixing materials, a can, a fine sieve for creating graphics, a measuring glass, and gloves. The materials used in this research consist of burnt ashes from empty oil palm bunches, starch, and water.

2. Preparation of Potassium Granule Fertilizer of Oil Palm Empty Bunch Burnt Ash.

- Prepare the ash:

If the ash is still coarse or large, sift it first to get a finer texture for easy processing into granules.

- Mix Ash with Binder:

Put the ash into a large container. Add starch binder, to make a dough that is easy to shape. The proportion of this mixture is about 150 grams of ash and 25 grams of starch binder.

Add Water:

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Slowly add a little water to the ash and binder mixture. Stir continuously until the mixture is moist enough to be compacted, but not too wet. This will help the ash and binder blend together as the amount of water added is 40% of the total material.

- Granular Shape:

Take a small amount of the dough mixture and form it into small balls or granulars by shaking in a cot.

- Granular Drying:

Once the granular is formed, put it in the oven at 40oC for a day to dry completely. Make sure the granular is completely dry to avoid spoilage or mold formation.

- Strain Dried Granulars:

After the granulars are dry, sieve them again to remove broken or too small granules, so that only intact granulars are used as fertilizer.

- Packaging:

Store the dried granular fertilizer in a sealed container to maintain its good quality when used.

- Research Procedure

The use of granular fertilizer can be done by spreading it around the plant roots and watering it so that it decomposes quickly in the soil.

- Working method

a) Weigh carefully 150 grams of burnt ash of Empty Palm Oil Bunches Put the sample (w1) into a bucket.

b) Weigh 25 grams of starch adhesive

c) Mix the two ingredients between burnt ash of Empty Palm Bunches and starch until homogeneous.

d) Add water as much as 40% of the weight of the mixed material.

e) Put it into the bed and do shaking motion until granular is formed.

- Moisture Content Testing

The principle of moisture content analysis is the process of evaporation of water from a material by heating. Determination of moisture content is based on the difference in sample weight before and after drying. The procedure for analyzing water content is as follows:

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a. A total of 10 g of the test sample was weighed in a porcelain cup.

b. Then put in the oven with a temperature of 105 ° C for 1 hour.

c. Then weighed the weight of the sample after drying, make sure the sample weight is constant after reheating.

- pH Testing

To measure pH in granular fertilizers, the following methods can be followed, which are generally simple and can be done with basic laboratory equipment:

Extraction Method with Water (1:10)

- Materials: Weigh about 10 grams of granular fertilizer.
- Dilution: Dissolve the sample in distilled water in a specific ratio, for example 1:10. This means you mix 10 grams of fertilizer with 100 ml of distilled water.
- Stirring: Stir the mixture for 10-15 minutes to ensure the substances in the fertilizer are dissolved.
- pH measurement: Measure the pH of the solution using a calibrated pH meter.

- Potassium Element Testing

To test the potassium (K) content of fertilizers, atomic absorption spectrophotometry (AAS) or flame photometry methods are generally used, depending on the availability of equipment in the laboratory. The following is a general procedure for the analysis of potassium element testing in fertilizers.

- Fertilizer Sample Preparation

- Drying: Dry the fertilizer sample in an oven at 105°C for several hours to remove moisture content. Drying is done to a constant weight to avoid the influence of moisture on the test results.
- Grinding and Screening: Grind the dried samples using a grinder to obtain uniform particle size. Filter using a 100 mesh sieve to obtain a homogeneous fine sample.

- Preparation of Sample Solution

- Weighing: Weigh about 1 gram of the fine fertilizer sample.
- Dissolution: Dissolve the sample in 50 ml of concentrated nitric acid (HNO_3) or a mixture of nitric acid with perchloric acid ($HClO_4$) at a specific ratio. Heat the solution carefully on a heating plate until all components are completely

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dissolved.

- Filtration: After the sample has dissolved, filter it using filter paper to separate the insoluble residue.
- Dilution: Dilute the filtrate to a specific volume (e.g., 100 ml) with distilled water. This solution will be used as the sample solution for potassium analysis.

• Analysis Procedure by Atomic Absorption Spectrophotometry (AAS) Method

- Apparatus Calibration: Calibrate the atomic absorption spectrophotometry apparatus using potassium standard solutions of known concentrations (e.g., 1 ppm, 5 ppm, and 10 ppm). The device is usually set at a wavelength suitable for detecting potassium (approximately 766.5 nm).
- Sample Measurement: Insert the sample solution into the atomic absorption spectrophotometry device. Record the absorbance value or light intensity measured by the device.
- Measurement of Standards and Blanks: Also measure the standard solution and blank (solution without potassium) to calibrate the measurement.
- Data Analysis: From the absorbance or light intensity data obtained, construct a calibration curve based on the standard solution. The potassium concentration in the samples is calculated by interpolating the absorbance values of the samples against the calibration curve.

• Analysis Procedure by Flame Photometry

- Instrument Calibration: Prepare potassium standard solution of known concentration (e.g., 10 ppm, 20 ppm, 50 ppm, and 100 ppm).
- Device Setup: Set the flame photometer at the appropriate wavelength for potassium (approximately 766.5 nm).
- Standard Measurement: Measure the flame intensity of the standard solution and construct a calibration curve from the measurement results.
- Sample Measurement: Put the fertilizer sample solution into the flame photometer and record the flame intensity value.
- Data Analysis: Use the calibration curve of the standard solution to calculate the potassium concentration in the fertilizer sample based on the read intensity value.

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RESULTS AND DISCUSSION

Result

Tabel 3 Design Yield and pH Measurement Experiment.

TKKS GRAY (gr)	Adhesive Material Weight(gr)	Yield (%)	pH (Unit)	Unsur Potassium (%)	Information
50	5	60.08	11.42	-	No granular formation
	10	65.32	11.24	-	No granular formation
	15	68.98	11.34	-	No granular formation
	20	67.02	11.52	-	Not formed granul
	25	65.32	11.45	-	No granular formation

Table 4 Design Test

TKKS GRAY (gr)	Adhesive Material Weight(gr)	Yield (%)	pH (Unit)	Unsur Potassium (%)	Information
100	5	68.08	11.52	-	No granular formation
	10	68.78	11.45	-	No granular formation
	15	66.73	11.52	-	No granular formation
	20	65.31	11.52	-	Not formed granul
	25	66.08	11.45	-	No granular formation

Table 5 Design Test

TKKS GRAY (gr)	Adhesive Material Weight(gr)	Yield (%)	pH (Unit)	Unsur Potassium (%)	Information
150	5	66.41	11.52	-	No granular formation
	10	60.25	11.52	-	No granular formation
	15	67.91	11.45	-	No granular formation
	20	59.57	11.23	38.25	Formed granular

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	25	67.22	11.26	36.72	Formed granular

Table 6 Design Test

TKKS GRAY (gr)	Adhesive Material Weight(gr)	Yield (%)	pH (Unit)	Unsur Potassium (%)	Information
200	5	62.41	11.52	-	No granular formation
	10	57.49	11.45	-	No granular formation
	15	46.49	11.14	37.80	Formed granular
	20	58.74	11.39	-	No granular formation
	25	65.31	11.40	-	No granular formation

Table 7 Design Test

TKKS GRAY (gr)	Adhesive Material Weight(gr)	Yield (%)	pH (Unit)	Unsur Potassium (%)	Information
250	5	67.56	11.46	-	No granular formation
	10	67.88	11.49	-	No granular formation
	15	67.92	11.47	-	No granular formation
	20	67.97	11.48	-	No granular formation
	25	68.78	11.45	-	No granular formation

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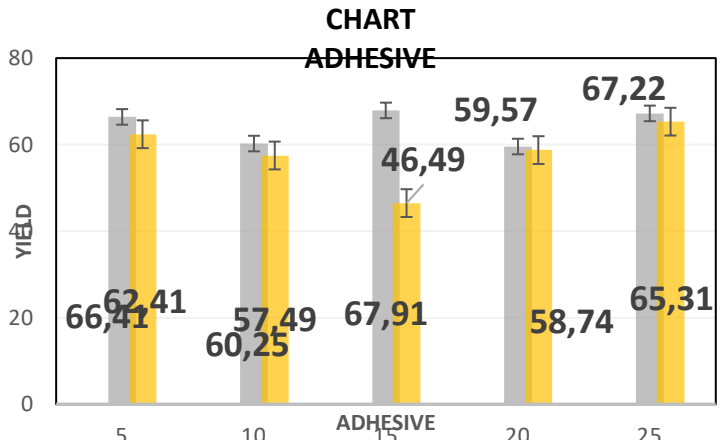

Figure 1 Yield vs Adhesive Material Graph

From the results the graph above can We pull conclusion that the amount material adhesive influential to results product (yield) with addition material 5 grams of adhesive in 150 grams of TKKS Ash will cause yield increase of 11.38% at the point balance.

If condition No balanced We add then Abu TKKS will causing low yields and emergence losses and products , granular not formed precisely ash stick to the wall tool granular former.

Table 8 Testing Design for Water Content of EFB Ash with a Weight of 50 grams

Adhesive Weight (gr)	Water Content (Hours)				
	12	24	36	48	60
5	30.67	34.67	35.61	33.84	33.70
10	30.78	34.38	35.30	33.39	33.40
15	34.33	35.07	35.94	33.93	33.98
20	32.22	34.94	35.80	33.78	33.80
25	31.54	32.75	33.69	31.64	31.74

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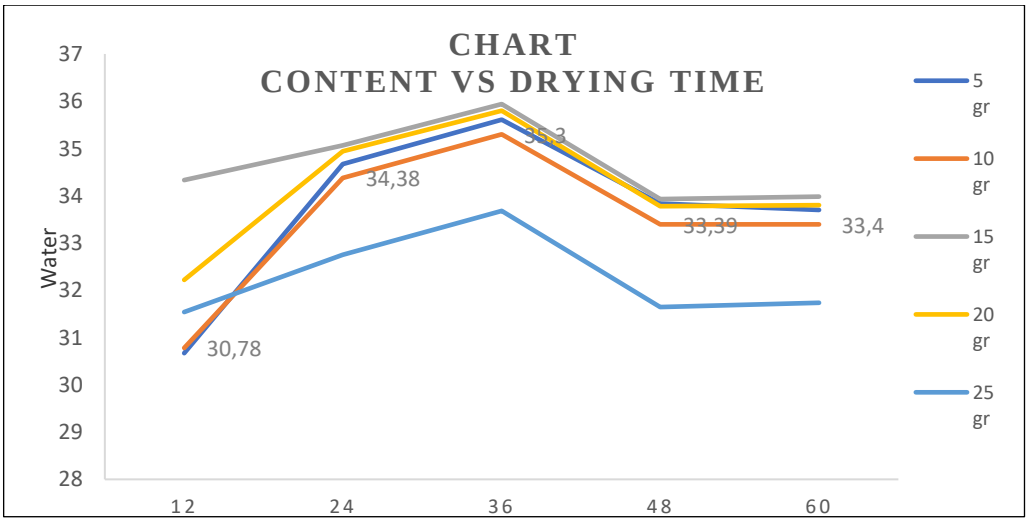

Figure 2 Graph of Water Content vs Drying Time

On the graph on with TKKS Ash weight 50 grams, with warmup temperature 40 ^{o} C We Enough do warmup for 36 hours, on the graph This addition adhesive No influential to water content of material standard , because decline variable water content adhesive tend No Far different .

Table 9 Testing Design for Water Content of EFB Ash with a Weight of 100 grams

Adhesive Weight (gr)	Water Content (Hours)				
	12	24	12	48	12
5	28.67	30.58	31.21	29.04	29.12
10	23.78	25.37	26.14	25.24	25.22
15	17.47	21.07	22.10	21.10	21.61
20	19.76	22.44	23.55	21.28	20.96
25	20.65	24.61	25.63	23.40	23.48

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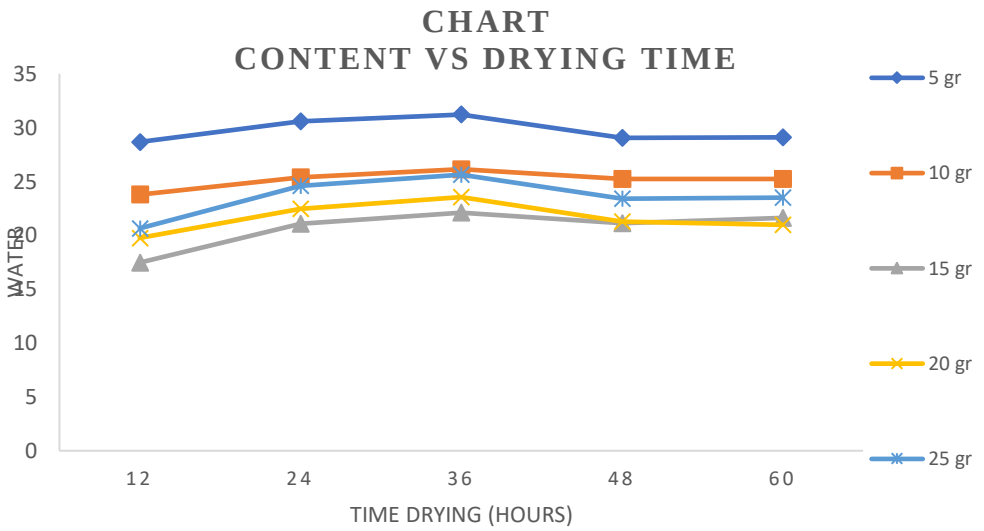

Figure 3 Graph of Water Content vs Drying Time

On the graph on with TKKS Ash weight 100 grams, with warmup our temperature is 40C Enough do warmup for 36 hours, because after 36 hours of heating with temperature 40C no experience increase water content of the mixture material .

Table 10 Testing Design for Water Content of EFB Ash with a Weight of 150 grams

Adhesive Weight (gr)	Water content (O'clock)				
	12	24	36	48	60
5	23.45	28.49	29.58	27.51	27.22
10	24.12	30.57	33.00	31.65	31.35
15	22.67	29.76	32.56	30.78	30.28
20	22.22	26.16	28.61	26.68	26.33
25	23.12	27.45	29.74	27.98	27.46

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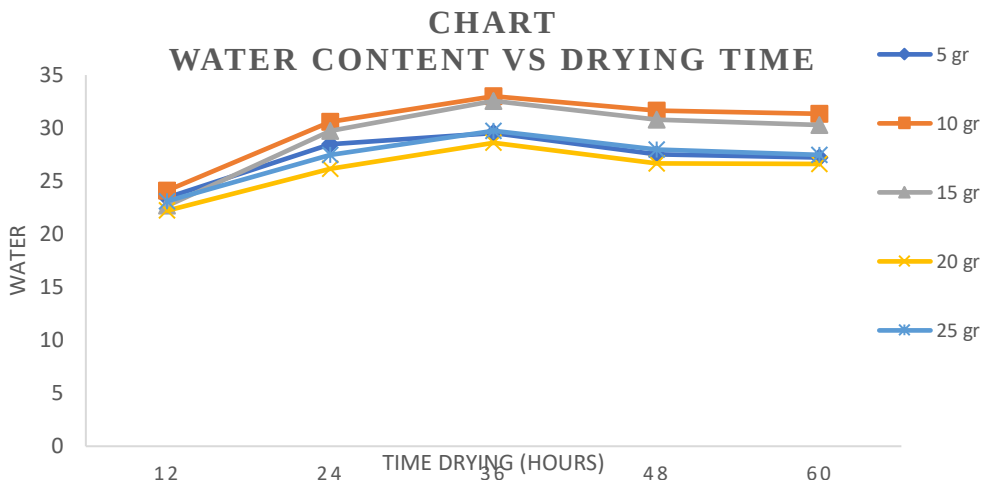

Figure 4 Graph of Water Content vs Drying Time

On the graph on with TKKS Ash weight 150 grams, with warmup our temperature is 40C Enough do warmup for 36 hours, because after 36 hours of heating with temperature 40C no experience increase water content of the mixture material .

Table 11 Testing Design for Water Content of EFB Ash with a Weight of 200 grams

Adhesive Weight (gr)	Water content (O'clock)				
	12	24	36	48	60
5	17.44	21.61	25.11	23.23	22.54
10	23.56	29.38	31.61	30.01	29.65
15	23.19	29.38	32.44	28.66	38.40
20	21.96	26.93	28.12	25.84	25.68
25	22.45	26.55	27.86	25.66	25.41

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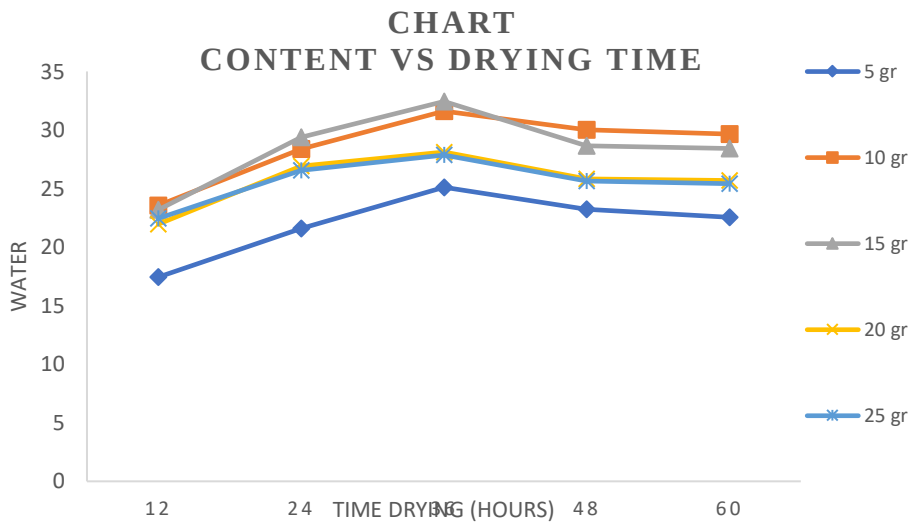

Figure 5 Graph of Water Content vs Drying Time

On the graph on with TKKS Ash weight 200 grams, with warmup our temperature is 40C Enough do warmup for 36 hours, because after 36 hours of heating with temperature 40C no experience increase water content of the mixture material .

Table 12 Testing Design for Water Content of EFB Ash with a Weight of 250 grams

Adhesive Weight (gr)	Water content (O'clock)				
	12	24	36	48	60
5	21.89	26.78	27.74	27.65	27.60
10	24.63	28.32	29.28	28.32	28.19
15	25.65	27.99	29.13	27,28	27.13
20	24.64	28.36	29.46	31.21	27.22
25	21.57	26.32	28.81	27.24	26.80

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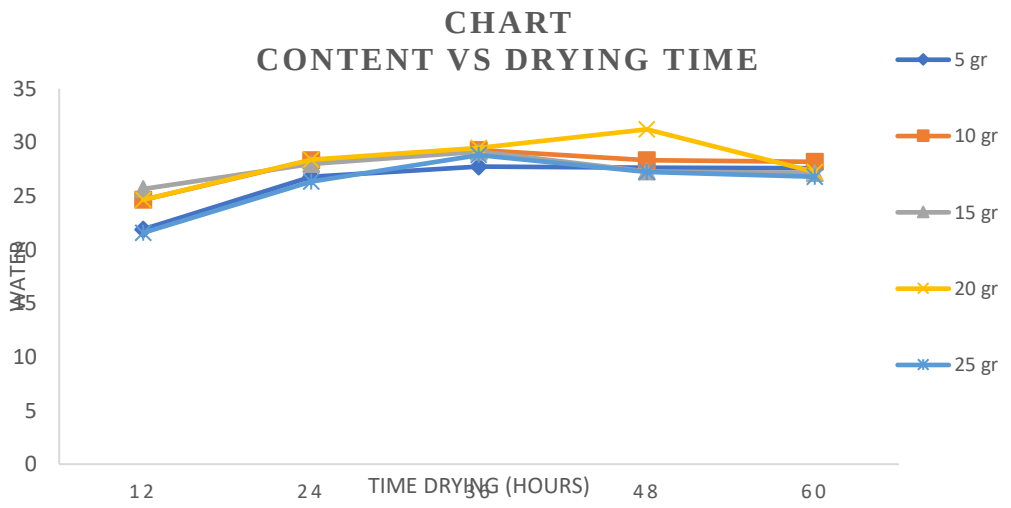

Figure 6 Graph of Water Content vs Drying Time

On the graph on with TKKS Ash weight 250 grams, with warmup temperature 40 ^{o} C We Enough do warmup for 36 hours, because after 36 hours of heating with temperature 40 ^{o} C No experience increase water content of the mixture material water levels tend to stable .

Initial Characteristics of Coconut Ash Palm oil

Analysis results beginning show that ash coconut palm oil own significant potassium (K_2O) content , namely by 40-41% by weight based on analysis with use AAS tool (**Attachment 3**)

Manufacturing Process Granular Potassium Fertilizer

Making process granular potassium fertilizer involves a number of stages , namely :

1. **Sifting :** Coconut ash palm oil filtered use 60 mesh sieve for to obtain size uniform particles .
2. **Mixing :** Ash that has been sifted mixed with material binder with ratio 13:1 (ash:binder).
3. **Granulation :** Mixture Then processed using a granulator with the addition of water as much as 40% of amount material For to form granules .

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4. **Drying :** The resulting granules dried at 40 °C for 36 hours.
5. **Packaging : The** resulting granules have been dry can packaged and marketed

Characteristics Test Granular Potassium Fertilizer

Test results show that granular potassium fertilizer has characteristics following :

- **content (K_2O):** 40 - 41% by weight .
- **Water Content:** 2-3%

Discussion

Potential of Coconut Ash Palm oil as Potassium Source

Coconut ash palm oil own high potassium content , making it material potential raw material For production fertilizer . The potassium content comes from from the combustion process waste coconut palm oil that oxidizes compound organic and leaves essential minerals .

Effectiveness of Granulation Process

Granulation process use material effective starch binder in to form stable granules . Addition of water to the granulation process help formation bond between particles , while the drying process use oven temperature 40 ^{0} C for stimulate drying use ray sun .

Performance Fertilizer in Potassium Release

Granular potassium fertilizer shows release nutrition in a way slowly , appropriately For need Plants . Release gradually This caused by the matrix slowing granules dissolution of potassium into in water. This is show that granular fertilizer from ash coconut palm oil can used as alternative efficient and environmentally friendly fertilizer environment .

Benefits Uses of Coconut Ash Palm oil

Utilization ash coconut palm oil as material standard fertilizer own a number of profit :

1. **Subtraction Waste :** Waste ash coconut potential palm oil pollute environment can utilized in a way economical .
2. **Efficiency Cost :** Production process use material standard waste more cheap compared to use material chemistry synthetic .

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3. **Sustainability :** This process support principle economy circular with utilise waste industry .
4. **Health:** Does not cause Health problems at the time applications in the field .

CONCLUSION

Based on the research conducted, it can be concluded that:

- EFB combustion ash contains 41.18% potassium, according to the Palm Oil Research Center (PPKS).
- The use of empty fruit bunch combustion ash as potassium fertilizer has been proven to reduce the use of chemical fertilizers due to its significant potassium content.
- Empty fruit bunch combustion ash is a fertilizer with a pH above 10, making it an alkaline fertilizer.
- In the process of producing granular potassium fertilizer from EFB combustion ash, granulation forms very well at a starch-to-ash ratio of 1:13 with the addition of 40% water based on the total weight of raw materials.
- In the process of producing granular potassium fertilizer from EFB combustion ash, the highest yield is achieved at a starch-to-ash ratio of 1:6 with the addition of 40% water based on the total weight of raw materials.

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