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# CHARACTERISTICS OF RICE HUSKS AND SILICA CONTENT FROM SEVERAL SUPERIOR VARIETIES IN WEST SUMATRA

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***ABSTRACT***

*Rice husk is a by-product of the process of breaking the husk from the milled dry grain during the milling process which is known as a ligno-cellulosic material high in silica content. Research that identifies silica levels in superior varieties in West Sumatra has never been done. The purpose of this research is to determine the variety with the highest silica content among the existing superior varieties, so that the variety with the highest silica content is known. The research method used is the experimental method. Samples of rice husks from six superior rice varieties in West Sumatra were taken from several areas in Kab / City West Sumatra which have superior rice varieties. There were three procedures carried out in this study. The first procedure was to prepare the husk for the pretreatment process, namely silica extraction by acid leaching with 2N HCl solution. The second procedures was to process the husk into silica ash, and the third stage was to determine the silica content of the silica ash. The results showed that the superior rice variety with the highest silica content was IR-42 variety with 95.759%, and the higher specific surface are was Kuriak Kusuik variety with 258.499 $m^2/g$.*



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Jurnal Katalisator Vol 9 No. 1 (2024) 262-271

## INTRODUCTION

Indonesia has the largest rice production in Southeast Asia, with rice production reaching 57.5 million metric tons in 2021 (Aseanstats, 2022). West Sumatra is one of the provinces with the highest rice production in Indonesia at 1.482 million tons. The increase in milled dry grain (MDG) production will be accompanied by an increase in rice husk byproducts. Rice husk is a by- product of the process of breaking the husk from dry milled grain during the milling process. The rice husk byproduct ranges from 20-22% of the MDG (Al-Abboodi et al., 2020). This means that if there is an increase in GKG of 57.5 million metric tons, it will produce rice husk of 11.5 million - 12.65 million metric tons. This is an environmental issue that is quite concerning because rice husks are very difficult to decompose.

Currently utilization of rice husk into something of high economic value has begun to be developed although it is not quite optimal. Rice husk is known as a ligno-cellulosic material that is high in silica content. The chemical composition of rice husk consists of 20.2 - 24.3% hemicellulose, 34.4 - 38.6% cellulose, 19.2-19.8% lignin, 18.7% silica and 0.39% metal oxide. (Ajeel et al., 2020). Its unique physical and chemical properties such as high ash and silica content can be used as an effective feedstock in the industry biomass as a renewable energy source (Mofijur et al., 2019), power generation (Fathurahman and Surjosatyo, 2022), source of nanosilica (Ajeel et al., 2020) applied as a biodegradable food packaging material (Cheng et al., 2021; Jabraili et al., 2021; Liu et al., 2021 and others).

However, the silica content of each variety is different, such as research conducted by Adiandri et al., (2017) where 52 varieties in Karawang Regency were tested, the silica content range was 23.4 - 37.56%. The highest silica content was found in the Ciherang variety at 37.56% followed by the Situ Patenggang variety at 36.16%, Inpari 31 and 21 at 36.16 and 36.01% respectively and Hipa 18 at 35.70%. Research that identifies silica levels and specific surface area of silica ash in superior varieties in West Sumatra has never been done, therefore it is necessary to conduct research to find out the varieties that contain the highest silica and specific surface are from superior varieties in West Sumatra as a reference basis for the use of nano silica raw materials.

## RESEARCH METHODS

### 2.1 Time and Place of Research

The research was conducted from September 2023 to August 2024. This research was conducted in several places including the Laboratory for Analysis of Material Properties and Agroindustry Products of Dharma Andalas University, Central Laboratory of Andalas University and LLDIKTI X Laboratory

### 2.2 Materials and Instrument

The main materials used in this study were six superior rice varieties in West Sumatra where the sampling of rice husks was taken from several areas in the Regency /

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Jurnal Katalisator Vol 9 No. 1 (2024) 262-271

City of West Sumatra which had superior rice varieties namely Junjuang from Agam Regency, Bujang Marantau from Padang Pariaman Regency, Kuriak Kusuik from Kamang Bukittinggi, Anak Daro and Cisokan from Solok Regency / City and IR-42 from Padang City. While the chemicals used are HCl 37% pa merk Smartlab and supporting materials in the form of distilled water.

The instrument used in the research include pH meter, thermometer, *Bunsen burner*, *furnace*, oven, Brunauer Emmett and Teller (BET) NOVA-1000 and X-ray fluorescence spectrometer (XRF) analyzer model QualiX-2000. In addition, some glassware was also used such as 500 ml beaker, 50 ml Erlenmeyer, funnel, 100 ml Measuring Flask, Burette, Desiccator, stirring rod, 50 ml Crucible, porcelain cup, and spray bottle.

### 2.3 Research Procedure

This research uses descriptive quantitative research methods in the form of experimental methods and literature studies. Laboratory experiment which aims to determine the physical and chemical characteristics of rice husk including moisture content SNI 3532: 2016, ash content SNI 14-0442-1989, and density of rice husk. Afterwards, the silica ash produced through the silica extraction process from rice husk was observed for its silica content and surface area. The sampling technique or data is done by purposive random sampling method, where the sample is taken from several helers that receive the most rice milling with predetermined varieties.

### Extraction Rice Husk and Preparation Husk Ash

The rice husk according to the treatment obtained was washed with water to remove the inherent dirt, dried in an oven at 105°C for 1 hour. Take 30 g of rice husk, soak in acid solution according to the treatment, namely HCl 2 M as much as 500 ml at 60°C for 30 minutes with constant stirring. Next, wash the rice husk using distilled water until it is free from acid, filter it and then dry it in an oven at 105°C for 1 hour. Burn the rice husk with Bunsen to form husk charcoal and burn it in a furnace at 600°C for 5 hours to form white to gray silica ash, then put it in a desiccator for 15 minutes, modification (Farhan and Ebrahim, (2021). The resulting silica ash was then characterized for yield, silica content and metal impurities with a wavelength dispersion X-ray fluorescence spectrometer (XRF), and specific surface area with the Brunauer, Emmett and Teller (BET) Method. After that the determination of yield refers to Eka Kusuma, (2022), where yield is the percentage of the main raw material that becomes the final product. It can be expressed in decimal or percent. With the following calculation:

$$Yiels = \frac{final\ weight}{initial\ weight} x100\%$$

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Jurnal Katalisator Vol 9 No. 1 (2024) 262-271

## RESULTS AND DISCUSSION

### Description of Grain of Some Rice Varieties

Rice has several diverse varieties which have specific characteristics that distinguish one variety from another. The following Table 1 is attached to the Grain description of several Superior Rice varieties in West Sumatra.

**Table 1**. Description of Grain from Several Superior Rice Varieties in West Sumatra

| Description | Superior Rice Varieties | | | | | |
|---|---|---|---|---|---|---|
| | **Junjuang** | **Bujang Marantau** | **Kuriak Kusuik** | **Anak Daro** | **Cisokan** | **IR-42** |
| Grain shape Husk | Slim | Slim | Slim | Slim | Oval - medium | Slim |
| Husk Color | Clean yellow | Straw yellow | yellow | Straw yellow | Clean yellow | Pure yellow, grain tips are the same color |
| 1000 grain weight (g) | 24,84[1)] | 20,58[1)] | 27,06[2)] | 22,43[1)] | 22[1)] | 23[1)] |
| Chaff Thickness | Thin | Thin | Somewhat Thick | Thick | Somewhat Thick | Somewhat Thick |
| Sightings |  |  |  |  |  |  |

Source: [1)] (Romdon et al., 2014) [2)] (Salfiati et al., 2024)

### Characteristics Of Rice Husk

Characterisation of the rice husk includes moisture content, ash content and density. The results of the analysis of the husks of several superior rice varieties produced are shown in Table 2.

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Jurnal Katalisator Vol 9 No. 1 (2024) 262-271

**Table 2**. Characteristics of rice husks of several superior varieties in West Sumatra

| No | Varieties | Moisture Content (%) | Ash Content (%) | Density (kg/m$^3$) |
|---|---|---|---|---|
| 1 | Junjuang | 8.5 | 16.89 | 164.7 |
| 2 | Bujang Marantau | 7.96 | 23.11 | 159.5 |
| 3 | Kuriak Kusuik | 7.96 | 23.23 | 151.5 |
| 4 | Anak Daro | 8.46 | 18.82 | 137.8 |
| 5 | Cisokan | 8.5 | 22.35 | 149.7 |
| 6 | IR-42 | 8.2 | 21.02 | 142.2 |

Based on the Table 2, it was found that the moisture content of rice husk from several superior varieties in West Sumatera ranged from 7.69 - 8.5%. The difference in moisture content between different varieties of rice husk is largely due to the drying process carried out in the mill before milling, which makes it easier to separate the husk from the grain.

Based on the Table 2, it was found that the ash content of rice husk from several superior varieties in West Sumatra ranged from 16.89 - 23.23%. According to Zou and Yang, (2019) rice husk when burned will produce a yield of 17 - 20% of rice husk ash which is light, large, and very porous with a density of around 180 - 200 kg/m3. In addition, low or high ash content is closely related to the content of organic compounds in it. It is suspected that the lower the ash content of rice husk, the higher the cellulose and lignin content of the rice husk.

Based on the results of the research, it was found that the density of rice husk from several superior varieties in West Sumatra ranged from 137.8 - 164.7%. According to Zou and Yang, (2019) the bulk density of rice husk ranges from 100 to 160 kg/m$^3$. The varying density of some of these superior rice varieties proves that differences in density are caused by different types of varieties.

## Characteristics Of Silica Ash

### a. Silica Ash Yield

Yield is the ratio of the amount of product produced in a process to the raw material in units of percent (%). Based on the results of the study, the yield of silica ash ranged from 5.5 -8.3%. The highest yield was found in the Bujang Marantau variety at 8.3%, while the lowest was found in the Anak Daro variety at 5.5%. The silica ash yield of several superior rice varieties in West Sumatra can be seen in Table 3.

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Jurnal Katalisator Vol 9 No. 1 (2024) 262-271

**Table 3.** Silica Ash Yield of Some Superior Rice Varieties in West Sumatra

| No | Varieties | Yield (%) |
|---|---|---|
| 1 | Junjuang | 5.9 |
| 2 | Bujang Marantau | 8.3 |
| 3 | Kuriak Kusuik | 7.8 |
| 4 | Anak Daro | 5.5 |
| 5 | Cisokan | 6.4 |
| 6 | IR-42 | 7.2 |

The yield of silica ash obtained in this study is lower than the yield of silica ash in general. According to Zou and Yang, (2019) rice husk when burned will produce a yield of 17 - 20% of rice husk ash which is light, large, and very porous with a density of around 180 - 200 kg/m3. The low silica ash yield is due to the soaking of the husk in HCl solution during the extraction process which hydrolyzes hemicellulose and cellulose into smaller compounds that can be easily decomposed during combustion.

In addition, the low or high yield of silica ash is closely related to the content of organic compounds in it. The low silica ash yield of the Anak Daro variety is thought to be caused by the high levels of organic compounds composed of the elements Carbon, Hydrogen and Oxygen contained therein, so that during the sooting process many organic compounds are completely oxidized. On the other hand, the high ash yield of the Bujang Marantau rice husk variety shows the low content of organic compounds, leaving behind many other non-organic compounds, in this case silica and minerals. The minerals contained can be in the form of impurity metals such as Na, K, Ca, Mg, Fe, Cu and so on. (Umeda and Kondoh, 2010; Wang et al., 2012)

In principle, the ashing process will remove the remaining organic compounds that make up the rice husk and completely oxidize all carbon into $CO_2$ gas, hydrogen into $H_2O$ vapor and Silica into $SiO_2$ and leave other non-organic compounds. (Sriyanto and Darwanta, (2017).. According to DTC-IPB in Nugraha and Rahmat, (2008) shows that the chemical composition of rice husk is composed of Carbon (C) component by 1.33%, Hydrogen (H) by 1.54%, Oxygen (O) by 33.64% and Silica by 16.98%. The following reactions occur during the sooting process (Sriyanto and Darwanta, 2017) namely:

$$\text{Compounds C, H and Si} + O_2 \rightarrow CO_2(g) + H_2O(g) + SiO_2(s)$$

**b. Silica content and chemical composition of silica ash**

Based on the research conducted, it was found that the silica content in the form of silicon dioxide in several types of superior rice husk varieties in West Sumatra ranged from 93.27 - 95.615%. The highest silica content is found in the husk of the IR-42 variety at 95.615% while the lowest is found in the husk of the Junjuang variety which is 93.27%. Meanwhile, when viewed based on the silica element content is in the range of 90.971% -

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Jurnal Katalisator Vol 9 No. 1 (2024) 262-271

93.613%. The chemical composition and silica content of some superior rice husk varieties in West Sumatra can be seen in Table 4.

**Table 4.** Chemical Composition and Silica Content of Some Superior Rice Husk Varieties in West Sumatera.

| No | Chemical Composition | Varieties | | | | | |
|---|---|---|---|---|---|---|---|
| | | Junjuang | Bujang Marantau | Kuriak Kusuik | Anak Daro | Cisokan | IR-42 |
| 1 | $SiO_2$ | 93.27 | 93.98 | 95.521 | 94.055 | 95.615 | 95.759 |
| | Si | 90.971 | 91.003 | 93.427 | 91.437 | 92.771 | 93.613 |
| 2 | Al $O_{23}$ | 0.675 | 0.658 | 0.356 | 1.055 | 0.315 | 0.217 |
| 3 | P $O_{25}$ | 3.089 | 3.998 | 3.207 | 3.375 | 3.163 | 3.108 |
| 4 | CaO | 1.226 | 0.278 | 0.719 | 0.787 | 0.876 | 0.825 |
| 5 | K $O_2$ | - | - | - | 0.234 | - | - |
| 6 | MnO | 0.415 | 0.106 | 0.004 | 0.01 | 0.004 | 0.003 |
| 7 | $TiO_2$ | - | - | - | 0.082 | - | - |
| 8 | Fe $O_{23}$ | 0.928 | 0.830 | 0.009 | 0.344 | 0.024 | 0.015 |
| 9 | ZnO | 0.001 | 0.076 | 0.002 | 0.006 | 0.003 | 0.021 |
| 10 | V $O_{25}$ | - | - | - | 0.001 | - | - |
| 11 | Ag $O_2$ | 0.278 | 0.077 | 0.181 | - | - | |
| 12 | Eu $O_{23}$ | - | | - | - | - | |
| 13 | Cl | - | | | 0.048 | - | |

The high or low silica levels shown in this study indicate that each variety has different silica levels, this can be caused by differences in genetic factors of each variety. In addition to genetic factors, nutrient content and fertilization patterns in the soil will also affect the silica content contained in the husk, considering that silica is one of the important elements for rice growth and is mostly taken from the growing medium, namely soil. The higher the silica content in the soil, the higher the silica content in the rice husk. This is reinforced by research from Farhan and Ebrahim, (2021); Lede et al., (2021); Zou and Yang, (2019) which state that the difference in silica content in rice husks is due to the higher silica content. which states that differences in silica content in several rice varieties can be caused by several factors including genetic factors, soil conditions where rice grows and others.

In addition, based on the chemical composition of each superior rice husk variety, it can be seen that only the anak daro variety is detected to contain $K_2O$, $TiO_2$ and $VO_{25}$ compounds. This can be seen from the color of the silica ash formed in Figure 1, where the color of the silica ash from the anak daro variety is light salem which is thought to be cause by the presence of $K_2O$, $TiO_2$ and $VO_{25}$ compounds. It is known that the color of the $K_2O$ compound is pale yellow, $TiO_2$ is white and $VO_{25}$ is yellow-orange. The following Figure 1. is attached to the appearance of silica ash from several superior rice varieties in West Sumatra.

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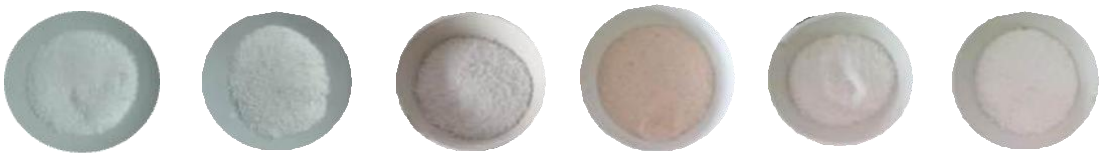
Jurnal Katalisator Vol 9 No. 1 (2024) 262-271



(a) (b) (c) (d) (e) (f)

**Fig 1.** Silica ash from several high yielding rice varieties in West Sumatra: (a) Junjuang, (b) Bujang Marantau, (c) Kuriak Kusuik, (d) Anak Daro, (e) Cisokan and (f) IR-42.

### c. Specific Surface Area of Silica Ash

The specific surface area of silica ash from several superior rice varieties in WestSumatra can be seen in Table 5.

**Table 5**. Specific Surface Area of Silica Ash of Some Rice Varieties

| No. | Varieties | Specific Surface Area of Silica Ash ($m^2$ /g) |
|---|---|---|
| 1 | Junjuang | 238.892 |
| 2 | Bujang Marantau | 254.518 |
| 3 | Kuriak Kusuik | 258.499 |
| 4 | Anak Daro | 235.540 |
| 5 | Cisokan | 240.623 |
| 6 | IR-42 | 242.765 |

Based on Table 5 above, it can be seen that the average specific surface area of silica ash of several varieties in West Sumatra ranges from 235.540 - 258.499 $m^2$ /g. This is also not much different from the research of Farhan and Ebrahim, (2021) where the surface area of silica ash obtained was 218 $m^2$ /g, and Ghorbani et al. (2015) in their research also obtained a specific surface area of silica ash of 272, 96 $m^2$ /g. The specific surface area is strongly related to the extraction method used. The specific surface area of silica ash of several rice varieties tends not to be much different, this is thought to be because the extraction process uses the same method, namely the *acid leaching* method with HCL as the compound. According to (Bakar et al., 2016) acid leaching produces a significant effect on the surface area and pore volume of silica where in their research it was found that the BET surface area and pore volume of acid leached silica were higher than unleached silica.

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Jurnal Katalisator Vol 9 No. 1 (2024) 262-271

## CONCLUSIONS

Based on the research showed that the superior rice variety with the highest silica content is IR-42 and it can be recommended as a raw material for nanosilica. However, based on specific surface area, the superior rice varieties with the highest specific surface area are Kuriak kusuik.

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