



## **Risk Of Heavy Metal Contamination In Rice Plants (Case Study In Linggasari Village)**

**Zaeni Budiono<sup>1</sup>; Suparmin<sup>2</sup>; Bahri<sup>3</sup>; Rachmah Melati<sup>4</sup>**

<sup>1</sup>Poltekkes Kemenkes Semarang, Jl. Baturraden KM. 12, Banyumas, Indonesia

Email : bahri@poltekkes-smg.ac.id

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### **Abstract**

Pollution of the heavy metal lead (Pb) in rice fields can affect the growth of paddy. This study aims to measure the levels of Pb metal in paddy (related to food safety status determined by WHO and BPOM) and describe the effect of Pb levels on the growth of rice plants (*Oryza sativa*) in the Linggasari village area, Banyumas. Samples were taken at agricultural locations divided into three sampling locations, namely the location of the roadside area, the middle area of rice fields and the area

of rice fields close to the flow of the river. Analysis of Pb levels used the Atomic Absorption Spectrophotometry (AAS) method. The results of the research that has been described, it can be concluded that the levels of lead (Pb) in paddy, on average, are 0.3 mg/kg and the lowest is 0.0 mg/kg, these results exceed the quality standards set by BPOM of 0.02 mg/kg.

**Keywords:** Heavy metal, Pb, rice

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## Introduction

Food is one of the basic human needs to sustain life apart from the need for clothing and boards. Apart from having nutritional value, food is also a medium for the growth of microbes or germs, especially perishable foods, namely foods that contain a lot of water content and high protein value. Another possibility is that the entry or presence of hazardous materials such as chemicals, pesticide residues and other materials, including dust, soil, human hair, can adversely affect human health (Sofiana, 2012). Diseases caused by food or food borne disease can be classified into two, namely food infection and food poisoning. Food poisoning is a food ingredient that does contain natural poisons or food containing toxic substances that have commercial purposes or economic values, for example heavy metal contamination (Amaliyah, 2017, h.13).

Rice (*Oryza sativa* L.) is a food crop that produces rice and occupies an important position in the Indonesian economy. Rice as a staple food, is difficult to be replaced by other staple foods (Apriliyani, 2022). Rice is a very important food crop in the world, rice plants are a staple food for more than half of the worlds population. Rice is needed as the main food for more than 90% of Indonesia population, because it has a high carbohydrate content and is the main energy source for Indonesians, especially in rural communities because rice is able to 35-60% of the bodys calorie needs (Sylvia, 2019).

The quality of rice is largely determined by rice cultivation activities carried out by farmers and regional and environmental conditions, where the use of inorganic fertilizers and industrial waste pollution has the potential to cause contaminants in plants (roots, stems, leaves and fruit). Environmental quality is influenced by the presence of heavy metals in water and soil. Mercury is a heavy metal with the highest toxicity followed by cadmium (Cd), silver (Ag), nickel (Ni), lead (Pb), arsenic (As), chromium (Cr), tin (Sn), and zinc (Zn). Heavy metals in the environment come from natural sources such as volcanic activity or chemical sediment processes. However, heavy metals can also come from industrial,



mining, agricultural and household waste disposal (Utami, 2019). Linggasari Village, Kembaran District, Banyumas Regency is one of the partner villages in the Tri Darma of Higher Education activities. According to the results of the preliminary survey, Linggasari Village farmers used pesticides that were not in accordance with the recommended doses in the processing of agricultural land.

Irrigation used in activities of agriculture is inseparable from chemical elements. The heavy metal lead (Pb) which is at the limit level of water quality standards in irrigation water sources when it is used to irrigate plants will be absorbed by plant roots, so that later it will be stored in the plant. Plants containing the heavy metal lead caused poisoning if consumed by humans (Amelia, Rachmadiarti and Yuliani, 2015).

Heavy metal contamination in rice cannot be ignored, because it can cause long term human health problems due to accumulation in organs, so the link between consumption of foods such as rice and health is very close and difficult to separate. The causes of diseases associated with food ingredients have increased consumer awareness regarding the quality and safety of food ingredients, so it is necessary to know the concentration of heavy metals in rice and to estimate its toxic value. Therefore it is necessary to monitor the content of heavy metal concentrations in rice.

## **Methods**

This type of research used a descriptive quantitative analysis method aimed at showing the presence of heavy metals Lead (Pb) and presence of metal Iron (Fe) and Magnesium (Mg) in rice plants in the Linggasari village area, Banyumas Regency. Samples were taken at agricultural locations divided into three sampling locations, namely the location of the roadside area, the middle area of rice fields and the area of rice fields close to the flow of river. Control is taken for each sample point in the paddy field area. Sampling of paddy was selected with a weight between 200-300 g during the rice harvest season, after that, take the rice fruits washed with water until clean and rinsed three times using distilled water. The



next preparation, carried out dry destruction by placing the paddy into a crusad cup, drying it in an oven (tannur) at 500° C until dry and a constant weight was obtained. The dried paddy fruit is then crushed into powder and stored in a dry and tightly closed glass container. Rice fruit powder was weighed as much as  $\pm 1$  g, then put in a beaker glass added with distilled water until the volume was exactly 50 ml then added 5 ml concentrated HNO<sub>3</sub> added 2 ml concentrated HCL and heated on a hot plate for 30 minutes. After chilling, add distilled water until the volume is 50 ml, then pour it into a glass bottle and filter it with a glass funnel that has been coated with filter paper. Then covered with aluminum foil. Analysis of lead (Pb), Iron (Fe) and Magnesium (Mg) content using an Atomic Absorption Spectrophotometer (AAS). In analyzing the content of heavy metal lead (Pb) in rice is descriptively.

## Results

Based on the results of the analysis of heavy metal content in rice fruit, the highest Pb content was 0.3 mg/kg and the lowest was 0 mg/kg. The highest Pb test results were in the middle location and the roadside of the rice fields so that the accumulation of Pb first entered the rice fields. This is in accordance with the results of testing for Pb levels in rice which is located in the middle of the rice field area with a test result of 0.3 mg/kg and the results of testing for Pb levels in rice which is located on the roadside area of rice fields with a test result of 0.3 mg /kg. However, the results of testing for Pb levels in rice located in rice fields close to water sources with a test result of 0 mg/kg indicating no Pb content in rice plants, the test uses a standard curve as can be seen in table 1. Data from the test results can be seen in table 2. Other factors that affect Pb levels in rice are possible to be absorbed from the soil such as when applying fertilizer when planting both organic and inorganic fertilizers because inorganic fertilizers contain chemicals to add or replace lost nutrients absorbed by previous plantings, can also be washed away by rainwater flow or react with other chemical elements that affect Pb levels in the soil. The distance of the land from the main road does



not affect the increase in the Pb content in the soil, because the farther the land is from the main road, the higher the Pb content in both the 0-20 cm layer and the 20-50 cm layer (Manurung, Oktoriana and Suharyani, 2023).

Table 1 Standard Curve for Analysis of Pb Levels

| Concentration (PPM)    | Absorbance |
|------------------------|------------|
| 0,1                    | 0,0001     |
| 0,5                    | 0,0044     |
| 1                      | 0,0075     |
| 1,5                    | 0,0158     |
| 2,5                    | 0,0253     |
| 3,5                    | 0,0355     |
| Y : 0.0105.X – 0.00012 |            |
| R2 : 0.9945            |            |

It is very important to monitor the concentration of heavy metals in agricultural land because it has an impact on the environment and public health. The main source of heavy metals on agricultural land is phosphate fertilizers so that reducing the use of phosphate fertilizers is one way that can be done to reduce the accumulation of heavy metals on agricultural land. Another factor that determines the differences in the levels of heavy metal concentrations in soil in various agricultural lands is the difference in the parent material of the soil (Handayani, Sukarjo and Dewi, 2022).

## Discussion

Pb levels in water and soil affect Pb levels in rice fruit. Pb in the water which then enters the soil will be absorbed by the roots, and will be spread to other plant parts. Heavy metals that penetrate the root endodermis cause other metals to be carried by the flow of transpiration to the top of the plant through the transport network (xylem) to other parts of the plant. Plant cells and tissues of the heavy metal Pb will experience a detoxification mechanism, for example by storing (stockpiling) the metal in certain organs such as fruit,



leaves and plant roots. The results of measurements of rice plant growth which included height, number of leaves and biomass that obtained high plant yields obtained the highest value with an average value of 7.86 ppm and the lowest value at 6.16. In the calculation of the number of leaves, the highest average value was 146.6 and the lowest average value was 117.6, while for plant biomass the highest average value was 276.6 and the lowest average value was 203.3. The results of the analysis of multiple linear regression equations of Pb content in water, Pb content in the substrate, and Pb in rice fruit, show that the Pb content in water and the Pb content in the substrate have a positive effect on the height and biomass of rice plants. The results of spearman correlation calculations from Pb levels in water, Pb levels in the substrate, to the number of leaves of rice plants, show that Pb levels in water and Pb levels in the substrate have a positive effect on the number of leaves of rice plants (Amelia, Rachmadiarti and Yuliani, 2015). This is because heavy metals in water will accumulate in the soil and mix with other nutrients, plant uptake of heavy metal ions in the soil is largely determined by the total amount of heavy metal ions in the soil.

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Table 2 Determination of The Results Testing for Pb Levels

| Sample                | Abs.   | Concentration (mg/L) | Levels (mg/kg) |
|-----------------------|--------|----------------------|----------------|
| Control               | 0,0002 | 0,0305               | 0,3000         |
| Middle of rice fields | 0,0002 | 0,0305               | 0,3000         |
| Side of the road      | 0,0002 | 0,0305               | 0,3000         |
| Water sources         | 0      | 0,0000               | 0              |

Pb metal is absorbed by plants when the organic matter content and soil fertility conditions are low, besides that the composition and soil pH, as well as the Cation Exchange Capacity (CEC) also affect the transfer of Pb from the soil to the plants. Heavy metal Pb in this condition will be released from soil bonds in the form of ions that move freely and then be absorbed by plants through ion exchange. The heavy metal Pb is absorbed by plant roots when other metals are unable to inhibit its presence. This will result in the soil being dominated by Pb cations, thus causing other cations to decrease in availability in the root



uptake complex. The Pb cation absorbed by the roots into the plant will become an inhibitor of enzyme formation and will then inhibit the process of plant metabolism, which includes the respiration process which will later produce ATP which is used for photosynthesis, then the results of photosynthesis will be used circulated for cell division (height, number and biomass ) and reproduction will be impaired. If this is done continuously in the long term it will cause a decrease in the quality of rice plant growth and result in disturbed plant growth. Heavy metal toxicity in the digestive tract occurs through feed contaminated with metals. so that it can interfere with digestive organs such as the intestine and liver as enzyme production. Toxicity can also occur through polluted water (Dahlan, 2017).

Toxic heavy metals present in paddy soil indicate that the area is experiencing environmental problems. Environmental problems that can cause soil damage can be grouped into soil chemical damage which is characterized by loss of soil fertility and the presence of chemical elements that are not needed by plants and humans who eat them (Adji, Sunarsih and Hamda, 2008). Most Indonesian farmers, use pesticides and herbicides to protect the land and maximize yields. Pesticides and herbicides used by farmers on vegetables such as carrots, potatoes, shallots, red chilies and cabbage in West and Central Java are classified as hazardous. Rosen CJ (2002) notes that lead easily accumulates in vegetables in the form of leaves and tubers. Rosen CJ (2002) also outlines that the threshold for lead in soil must be less than 300 ppm (Salamahu, 2012).

The ongoing division and elongation of plant cells will spur the growth of plant shoots and will eventually encourage an increase in plant height. The resulting compounds are used in the process of division and enlargement or differentiation of plant cells. The ongoing division and elongation of plant cells will spur the growth of plant shoots and will eventually encourage an increase in plant height, number of leaves and plant biomass. The content of the element K is low and the heavy metal Pb is very high, causing the concentration of nutrients in the soil to be unbalanced. High Pb will cause the process of absorption of nutrients by plants to be different because the amount of Pb cations in the soil is more than



the nutrients needed by plants. A plant will grow well and thrive if all the nutrients needed are in sufficient quantities and available to the plant. The nutrients needed by plants are available in sufficient quantities, so the results of metabolism such as the synthesis of biomolecules will increase. This causes cell division, elongation and maturation of tissues to become more perfect and faster, resulting in faster volume and weight gain which in turn results in better plant growth (Amelia, Rachmadiarti and Yuliani, 2015).

The chemical properties of the soil will affect the interactions between contaminants. Soil is formed from various mixtures of minerals and decay products such as organic matter. The mineral composition, crystal structure, and environmental conditions surrounding the soil will play a major role in determining the nature of the reactions between contaminants that come in contact with the soil particles. Minerals dominated by aluminum and iron, for example in general, will be more reactive than minerals dominated by silica. Soil organic matter is an indicator of soil quality, because it is a source of essential nutrients and plays an important role for aggregate stability, water holding capacity and soil structure. Therefore, soil organic matter is closely related to soil conditions both physically, chemically and biologically which in turn determines the productivity of a land (Suriani, 2016).

The biggest source of lead metal pollutant comes from motorized vehicle exhaust, so that if plants are planted or sold on the side of the main road, they will become a mediator for the spread of lead heavy metal. Plants, which are mediators of the spread of heavy metals in living things, absorb heavy metals through their roots and leaves (stomata) which will then enter the food chain cycle. If we consume foods that contain lead continuously, it will result in a buildup of lead in the body, especially in the kidneys, liver and tissues which has a dangerous impact, which can inhibit the activity of enzymes involved in the formation of hemoglobin (Hb), damage brain nerve tissue, and gastrointestinal disturbances. Heavy metals that enter the human body will interact with enzymes and proteins including DNA through metabolic processes. The presence of excess amounts of heavy metals in the body will adversely affect the body, because lead can combine with active enzymes to become



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inactive, so that the synthesis of human blood granules (Hb) can be inhibited as a result can cause anemia (Sinurat, 2018).

### **Conclusion and Recommendation**

Based on the results of the research and discussion that has been described, it can be concluded that the levels of lead (Pb) in paddy, on average, are 0.3 mg/kg and the lowest is 0.0 mg/kg, these results exceed the quality standards set by BPOM of 0.02 mg/kg. The influence of the heavy metal Pb in water and substrate has a positive effect on the growth of rice plants (including plant height, number of leaves and biomass). Therefore, it must still pay attention to the safety of consuming rice that is irrigated with Pb polluted irrigation.



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