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Heavy Metal Analysis Using Inductively Couple Plasma – Optical Emission Spectrometry (ICP-OES) on Hair of Breast Cancer Patients

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Abstract:- Heavy metals can be found in everyday environments and can enter the human body through food, water, and air. Heavy metals are categorized into three groups by the World Health Organization (WHO): essential elements such as Copper (Cu), Chromium (Cr), Cobalt (Co), Iron (Fe), and Zinc (Zn); potentially essential elements like Manganese (Mn) and Nickel (Ni); and potentially toxic elements such as Cadmium (Cd) and Lead. (Pb). The heavy metal is a systemic poison that causes organ dysfunction in humans. The aim of this research is to analyze the levels of heavy metal elements Copper (Cu), Iron (Fe), and Zinc (Zn) in the hair of breast cancer patients. The method used to measure heavy metal content is Inductively Coupled Plasma – Optical Emission Spectrometry. (ICP-OES). The levels of heavy metal elements Cu, Fe, and Zn in five hair samples from breast cancer patients differ from the standards GBW07601 and IAEA-086. The levels of Cu and Fe in breast cancer patients are lower than the standard, while the level of Zn is higher than the standard.

Keywords:- *Heavy Metal, ICP-OES, Breast Cancer.*

I. INTRODUCTION

Heavy metals can be found in everyday environments and can enter the human body through food, water, and air [1]. Heavy metals are necessary for living organisms to regulate various chemical and physiological functions of the body [2]. The excess or deficiency of heavy metal levels can pose health threats to humans. Specifically, elements such as Cu, Cr, Co, Fe, Zn, Mn, Ni, Cd, and Pb are among the heavy metals that cause health issues. Heavy metals are systemic toxins that cause organ dysfunction in humans, even at low levels in the body. Heavy metal exposure poses a threat to health, such as breast cancer; the concentration of heavy metals in the bodies of breast cancer patients differs when compared to those who do not have breast cancer [4]. The influence of heavy metals on breast cancer can be determined by measuring the levels of heavy metal elements present in the bodies of breast cancer patients. The measurement of element levels in the body can be done in several parts of the human body, such as blood, urine, nails, and hair. Hair can incorporate heavy metals into its structure during the growth process [5]. The concentration of heavy metals in hair can reflect the average level of heavy metal concentration in the human body [6]. Heavy metals can be analyzed for their elemental content using several methods, one of which is Inductively Coupled Plasma – Optical Emission Spectrometry. (ICP-OES). The working principle of ICP-OES is to carry out a combustion process on the specimen using plasma generated from the combustion of argon gas. During the combustion process of the specimen, an electron emission process occurs, in which the electrons release energy with varying wavelengths that specifically identify the elements contained in the test object [7]. The aim of this research is to analyze the levels of heavy metal elements Copper (Cu), Iron (Fe), and Zinc (Zn) in the hair of breast cancer patients using Inductively Coupled Plasma – Optical Emission Spectrometry. (ICP-OES).

II. METHODS

This research was conducted at the National Research and Innovation Agency (BRIN) using the Inductively Coupled Plasma – Optical Emission Spectrometry method. (ICP-OES). The research sample was taken from Dr. Kariadi General Hospital and K.R.M.T Wongsonegoro Regional General Hospital. A sample taken from the human body is five grams of head hair. This sample was taken from five breast cancer patients based on the inclusion and exclusion criteria as follows:

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➢ *Inclusion Criteria:*

- Fertile adult women aged 18 to 50 years.
- Ideal body weight with an ideal BMI of 18.5 to 24.9.
- Normal kidney function

➢ *Exclusion Criteria*

- Hair coloring for the last five months.
- Has chemotherapy or radiotherapy ever been performed

The Hair Sample is then Cut with scissors into small pieces, and the sample size passes through a 100 mesh sieve. The hair sample that meets the criteria is stored in a plastic bag. Next, sample preparation is carried out using the wet construction method as follows:

- The sample was measured at one gram.
- The sample is placed into a 100 ml beaker.
- The sample was added with two ml of Nitric Acid and allowed to sit for 30 minutes.
- The sample is heated on a hotplate stirrer at a temperature of 100 °C.
- The hotplate stirrer temperature is raised to 180 °C.
- After being heated to 180 °C, three ml of Nitric Acid solvent remains, and the smoke that comes out is white.
- The sample is cooled and then filtered using filter paper.
- The sample was added to 100 ml of distilled water using a measuring flask.
- The sample is placed into a glass bottle that has been rinsed with alcohol.

Sample testing using ICP-OES shows the elements Copper (Cu), Iron (Fe), and Zinc. (Zn).

III. RESULT AND DISCUSSION

The results of the heavy metal content of Cu, Fe, and Zn from five hair samples of breast cancer patients were compared with the standards IAEA-086 and GBW07601, as shown in Table 1. IAEA-086 represents the standard values of heavy metal content found in the hair of European individuals, while GBW07601 represents the standard values for the hair of Chinese individuals. The values of the elemental content of the hair samples from breast cancer patients Sample 1, Sample 2, Sample 3, Sample 4, and Sample 5 are presented in Table 2.

Table 1: Standard Human Hair

Standard	Concentration Value of Cu (ppm)	Concentration Value of Fe (ppm)	Concentration Value of Zn (ppm)
Reference material IAEA-086	17,6	123	167
Certificate of Certified Reference Material GBW07601	10,6	54	190

Table 2: The Values of Cu, Fe, and Zn Content using the ICP-OES Method

Sample Name	Concentration Value of Cu (ppm)	Concentration Value of Fe (ppm)	Concentration Value of Zn (ppm)
Sample 1	0,00	12,26	678,58
Sample 2	8,50	10,60	499,33
Sample 3	4,89	10,00	110,11
Sample 4	4,68	28,03	660,44
Sample 5	6,21	99,98	346,98

The levels of the heavy metal element Cu from five hair samples of breast cancer patients compared to the IAEA-086 standard and the GBW07601 standard can be seen in Figure 1. The sample values for Sample 1 were not detected because they were below 10 ppb, while the values for Sample 2, Sample 3, Sample 4, and Sample 5 were lower than the hair of a normal person not affected by cancer, which is 10.60 ppm (GBW07601) and 17,60 ppm (IAEA-086). The low levels of Cu in breast cancer patients also support previous research conducted on breast tissue [8]. A deficiency of copper (Cu) adversely affects brain development, mitochondrial function, ceruloplasmin activity, and has negative impacts on the central nervous system, leading to neurological symptoms [9].

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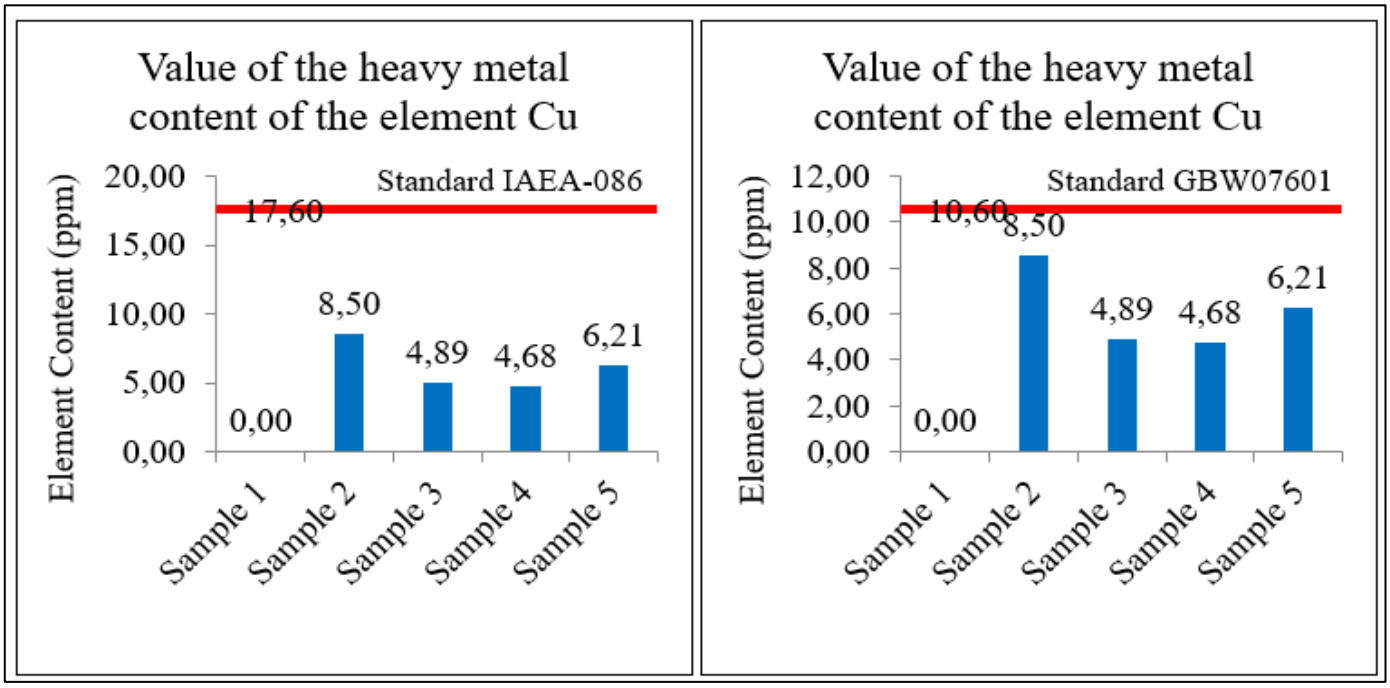

Fig 1: Graph of Cu Content Values with Standard IAEA-086 and GBW07601.

The levels of the heavy metal element Fe from five hair samples of breast cancer patients compared to the IAEA-086 standard and the GBW07601 standard can be seen in Figure 2. The sample value of Sample 5 is almost close to the IAEA-086 standard value of 123 ppm. In contrast, compared to the GBW07601 standard, the value of Sample 5 is higher than the standard, which is 54 ppm. The values of the Sample 1, Sample 2, Sample 3, and Sample 4 are lower than both standards.

A deficiency of iron (Fe) is a cause of anemia, affecting various bodily functions such as hemoglobin formation, the immune system, oxygen transport, and cellular respiration [10]. In previous research, the iron content in breast cancer patients was found to be higher, which may be influenced by the different dietary factors consumed in various regions [11].

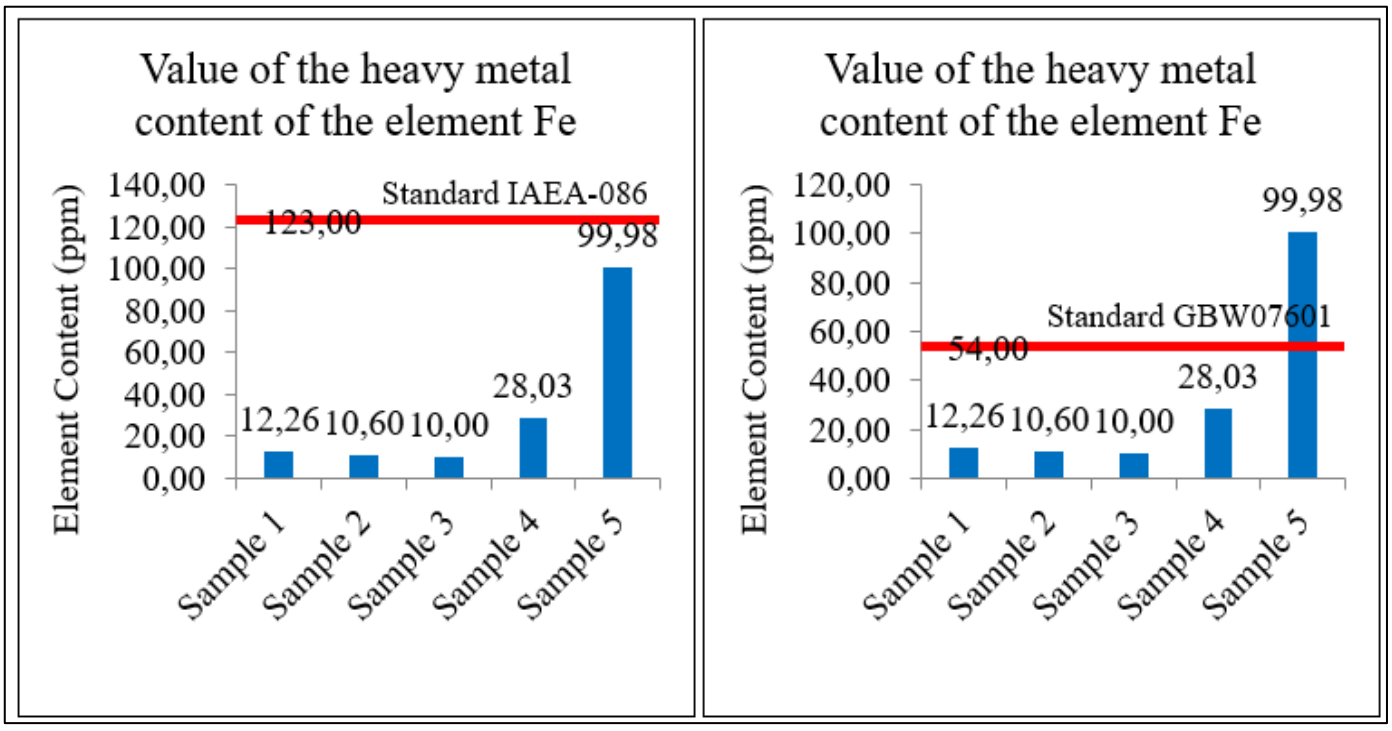

Fig 2: Graph of Fe Content Values with Standard GBW07601 and IAEA-086.

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The levels of the heavy metal zinc from five hair samples of breast cancer patients compared to the IAEA-086 standard and the GBW07601 standard can be seen in Figure 3. The sample values of Sample 3 are close to both standards. Meanwhile, the sample values of Sample 1, Sample 2, Sample 4, and Sample 5 are higher than the standards, which are 190 ppm (GBW07601) and 167 ppm. (IAEA-086). The advantage of Zn elements in breast cancer patients supports previous research conducted on breast tissue [12]. The excess of Zn causes symptoms such as dizziness, weakness, and focal neuronal reduction. At high levels, Zn will extensively destroy cortical cells in tissue culture [13]. The hair samples of breast cancer patients analyzed showed that the levels of the heavy metal elements Cu and Fe were lower than the standard values for hair from humans without cancer, while the Zn levels were higher compared to the standard values for hair from individuals without cancer. The results obtained allow us to conclude that the levels of heavy metals have an impact on breast cancer patients. The results obtained are also in line with the hypothesis and several previous studies, thus further research is needed to examine the influence of heavy metals on breast cancer patients by comparing hereditary factors, lifestyle, and living environment.

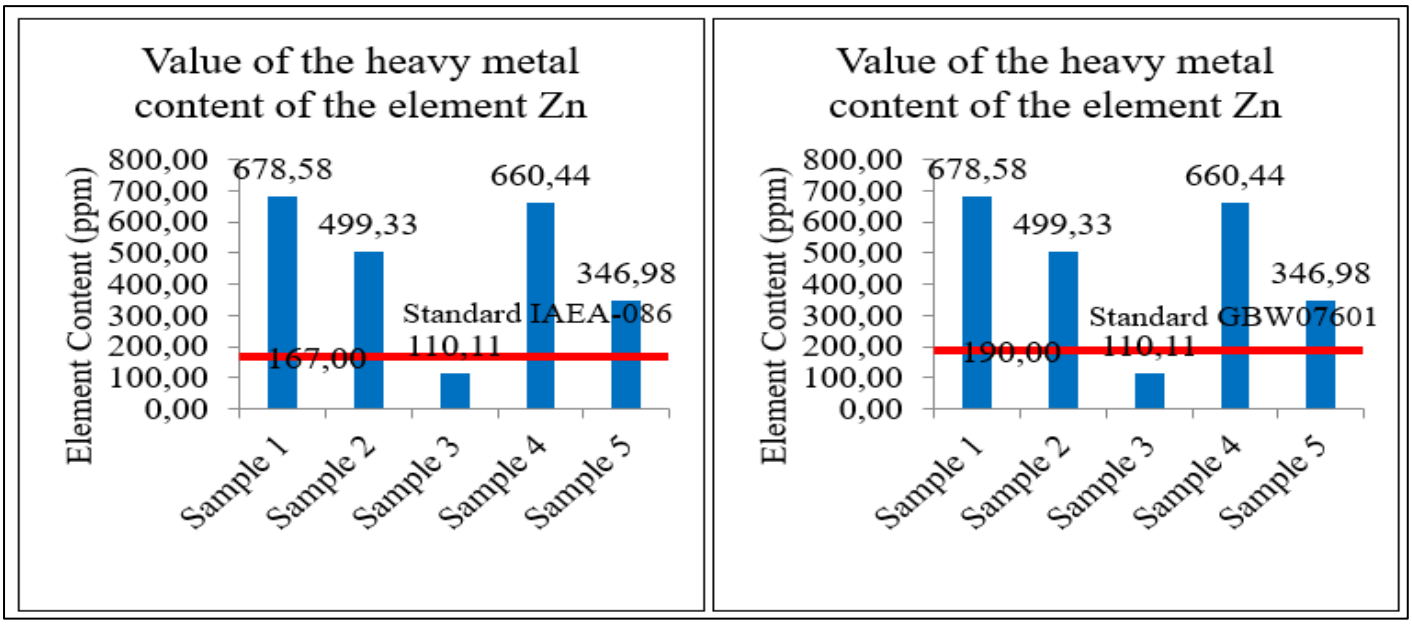

Fig 3: Graph of Zn Content Values with Standard GBW07601 and IAEA-086.

IV. CONCLUSION

The levels of heavy metal elements Copper (Cu), Iron (Fe), and Zinc (Zn) in the hair samples of breast cancer patients show results that differ from the standard references IAEA-086 and GBW07601. The levels of Cu and Fe are lower than the standard, while the level of Zn is higher.

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