Physicochemical Characterization of Concentrated Mineral and Magnesium Isolate of Sea Water Pamekasan Madura

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INTRODUCTION

Indonesia is a maritime country with 75% of the total territory. The sea area (inland waters, islands and territorial sea) is 3,351 million km², the waters of the Exclusive Economic Zone and the continental shelf are 2,936 million km². The length of the coastline of Indonesia is approximately 99,093 km (Badan Informasi Geospasial, 2017). The total number of villages recorded has a salt-raising business of 493. It is the smallest number compared to other types of businesses located in the seaside area with total salt production in 2015, around 2,768,809.95 tons (Central Bureau of Statistics, 2018). Seawater contains many types of minerals. The mineral content with the highest amount is Sodium, Magnesium, Potassium, Calcium and Boron (Mero, 1965). The mineral content in Indonesia seawater has a higher level than seawater in Egypt, China, India, Singapore and Uganda (Apriani et al., 2018).

Minerals have an important role in maintaining human physiological and metabolic conditions.
There have been many studies on the health benefits of seawater, including cholesterol, cardiovascular, atherogenesis, blood pressure, obesity, diabetes, hepatic, skin, fatigue, gastritis, osteoporosis, and cataracts (Nani et al., 2016). Seawater minerals have been reported to have a protective effect against exercise-induced muscle damage (Hou et al., 2013). Iron contained in seawater minerals also correlates to increased levels of faecal immunoglobulin A (IgA), which represents an increase in immune function (Shiraishi et al., 2017). The use of concentrated minerals as a product has also been widely commercialized, for example, Sea M.D-Anderson Health Solution, Revell Global-Concentrated mineral Drop, dan ISLANDS brand Ocean Mineral Topical Facial Serum.

Based on the commercial potential and benefits of seawater concentrate mineral, which can be processed into a source of medicinal raw materials, this research was conducted to characterize concentrated minerals and magnesium isolates from Pamekasan Madura seawater.

**MATERIALS AND METHODS**

**Materials**

The materials used in this study were Pamekasan Madura seawater, Aquabides, Calcium Chloride, 1,4-dioxane, 65% Nitric Acid, standard Mg, Filter Paper.

**Extraction of Concentrated minerals from seawater**

The concentrated mineral was made through a natural evaporation process in a salt pool in a greenhouse. The draining of seawater was gradually carried out until the Concentrated mineral was obtained with a BE value of 36. The process of extracting the concentrated mineral can be seen in Figure 1.

The mineral content was determined using ICP-OES (PlasmaQuant PQ 9000 Series, Analytikjena, Germany). A sample of 200 mL was measured for viscosity and pH.

**Magnesium Isolation from Concentrated minerals**

Isolation of magnesium was carried out by precipitating sulfate ions through the addition of a calcium chloride solution producing calcium sulfate deposits. The solution was filtered using filter paper. The filtrate was then evaporated at 35°C for 24 h to remove some of the potassium ions as a potassium-magnesium double salt (KCl MgCl₂.6H₂O) so that a solution consisting of Mg and Cl ions was produced. The filtrate solution was then reacted with 1,4-dioxane (C₄H₈O₂) to precipitate the magnesium chloride salt to produce a precipitate of MgCl₂.6H₂O C₄H₈O₂ (Sample). The sample was then dried at constant temperature (100°C) to remove dioxane molecules and magnesium chloride hexahydrate MgCl₂.6H₂O was produced. (Fezei et al., 2012).

**Magnesium Purity Analysis**

**Sample Preparation**

The sample was weighed as much as 0.5 grams in a beaker glass. Added 3 mL of HNO₃ 65%, then heated on the stove until dissolved. The sample was cooled at room temperature, then transferred and filtered into a 100 mL measuring flask and distilled water was added to the mark. Pipette 10 µL sample into a 10 mL measuring flask and add distilled water to the mark limit.

**Preparation of Mg standard curve**
Table 1: Comparison of the mineral content of Pamekasan Madura and Taiwan Yes seawater

| No | Mineral | Surface seawater | Concentrated mineral | Mg isolate | Surface seawater | Deep seawater |
|----|---------|------------------|----------------------|------------|------------------|---------------|
| 1  | Mg      | 14846.081        | 20685.5644           | 295.0440   | 1290             | 96100         |
| 2  | Na      | 113431.0243      | 32948.8012           | 2241.7200  | 10800            | 7240          |
| 3  | Ca      | 616.1930         | 349.7602             | 9.5532     | 411              | 39            |
| 4  | As      | 1.8847           | 4.7652               | 0.0682     | -                | -             |
| 5  | Cd      | 0.4440           | 0.5894               | 0.0224     | -                | -             |
| 6  | Cr      | 244.7948         | 98.7313              | 0.0243     | 0.0002           | 0.087         |
| 7  | Cu      | 2.6692           | 6.0440               | 0.0340     | 0.0009           | 0.22          |
| 8  | Fe      | 1370.1993        | 436.8681             | 0.0672     | 0.003            | 0.25          |
| 9  | Hg      | <0.0001          | <0.0001              | <0.0001    | -                | -             |
| 10 | Pb      | 5.7628           | 6.1788               | 0.0422     | -                | -             |

Metal standard Mg series solutions were made in 0.2, 0.4, 0.6, 0.8, 1 ppm. The absorbance value of Mg standard solution was measured at 285.2 nm by Atomic Absorption Spectrophotometry (Shimadzu AA-7000, Shimadzu, Japan).

RESULTS AND DISCUSSION

Characterization and Analysis of Concentrated mineral Content

Seawater used comes from the surface of the Madura Pamekasan beach. A concentrate mineral solution was obtained with a BE value of 36. The clear solution was yellowish, salty, and odourless (Figure 2).

Figure 2: Concentrated Mineral Solution

Concentrated mineral of Pamekasan Madura has a pH of 6.1. Overall, Indonesiaseawaterer has a pH range of 6.0-8.5 (Rukminasari et al., 2016). Research conducted by Mirna et al. (Apriani et al., 2018) seawater of Pamekasan Madura has an average pH of 8.2. The carbon dioxide content dramatically influences the pH of seawater. Carbon dioxide forms carbonic acid (H2CO3), bicarbonate ions (HCO3-) and carbonate ions (CO3-) by reaction with seawater. Generally, the amount of organic carbon available is in the form of carbonate ions which its formation will release (H +). So that by increasing the concentration of carbon dioxide will increase the pH of the concentrated mineral.

The viscosity of concentrated mineral of the Pamekasan Madura seawater was obtained at 15 mPa.s. Seawater bittern has a viscosity of 13.2 mPa.s and a saturated MgCl₂ solution has a viscosity of 12.8 mPa.s (Lychnos et al., 2010). This indicates that the Pamekasan Madura seawater minerals have been concentrated, especially for MgSO₄ or MgCl₂. Iseawaterer, the structure supporting salts (NaCl and MgSO₄) are more available than the decomposition salt (KCl). So that by increasing the concentration of the structure supporting salt will increase the viscosity of the concentrated mineral through electrostriction and hydration (Guan et al., 2015).

Based on research conducted by Mirna et al. (Apriani et al., 2018) seawater of Pamekasan Madura has a BE value of 3. BE value describes the degree of viscosity of seawater. The density of the concentrated mineral is 1.318 - 1.330 g/cm³, which was calculated using the following equation (Blair and Peffer, 1944):

\[
\text{Density} = \frac{145}{145 - \text{BE}}
\]
Taiwan Yes seawater (Sheu et al., 2013). After going through deposition, the levels of some heavy metals in the concentrated mineral begin to decrease. In magnesium isolate, the content of heavy metals such as, As, Cd, Cr, Cu, Fe, and Pb decreased significantly. The purity analysis of magnesium isolates using SSA was obtained with a percentage of the Magnesium content of 10.88%.

CONCLUSIONS

The seawater of Pamekasan Madura has high mineral content. The concentrated mineral has a viscosity and density of 15 mpa.s and 1.318 - 1.330 g/cm$^3$. The magnesium isolate obtained has a purity of 10.88%. Based on the results, Pamekasan Madura seawater can be used as a source of raw materials for mineral medicines.

Conflict of Interest

The authors declare that they have no conflict of interest.

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