Comparison of micronutrients content (Fe, Cu, Mn) in cacao beans from plantation area and transmigration area in East Luwu

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Abstract. This study aims to comparison micronutrient (Fe, Cu and Mn) concentrations in cacao beans and its potential as food product for fulfilling body nutritional adequacy, cacao beans comes from plantation area and transmigration area. The content of micronutrient was analyzed by Inductively Coupled Plasma (ICP)-OES Perkin Elmer Optima 8300. The results obtained that the average content of Fe, Cu, and Mn in cacao beans from plantation and transmigration area were 2.022 mg/100 g; 3.009 mg/100 g; 1.571 mg/100 g and 2.684 mg/100 g; 2.202 mg/100 g; 1.801 mg/100 g respectively. Analysis results indicated that Fe, Cu and Mn content in cacao content from plantation and transmigration area can be used as raw material for food products to fulfill the body nutritional adequacy.

1. Introduction

Cacao (Theobroma cacao L.) is one of the family Sterculiceae from Theobroma’s genus, its origin from Amazone and other tropical regions in Central and South America [1]. The opportunities for Indonesian cacao market are quite big, both exports and domestic demands. The strategic role of the cacao commodity has become an attraction for the development of research today, especially related to nutrition in cacao beans. Cacao beans are a source of nutrients which are very rich in essential minerals [2].

Minerals are components of all body tissues and found in large amounts in bones, teeth and nails. Minerals are generally classified into two, namely macro and micro. Essential macro and micro mineral contained in cacao beans have been investigated by analyzing samples from 23 locations of countries which production cacao. The analysis results obtained indicate that the most abundant mineral content is potassium (K), which is equal to 10 g/kg. Furthermore, for phosphorus (P), magnesium (Mg) and calcium (Ca) the results of concentrations ranging from 10 mg/kg to 1 g/kg are obtained. Whereas the concentration of aluminum (Al) and iron (Fe) is between 1 g/kg and 100 mg/kg. Elements of zinc (Zn), rubidium (Rb), manganese (Mn), boron (B), copper (Cu), sodium (Na) and strontium (Sr) are all present at concentrations between 10 mg/kg and 100 mg/kg [3].
Studies on essential macro and micro mineral in cacao beans has been carried out in countries which production cacao based on the importance of essential minerals in cacao as a source of nutrition in cacao-processed food products. But generally for commodity cacao in Indonesia do not have the data. The contents of the essential macro and micro mineral themselves can vary in cacao beans due to several factors. These factors include the fertilization process, genetic origin, seasonal or annual factors, harvest conditions, storage, processing and environmental pollution [4]. Previous studies indicate that there is a difference in the distribution of micro mineral in each region.

One of the largest cacao production centers in Indonesia is in East Luwu District with an income of 10,222 tons in 2014 [5]. The land of cacao plantations in East Luwu is at least two types of land which are sought as cacao farm areas, namely the plantation area which from the beginning was used as plantation land and the location of plantations in transmigration areas. Based on the above explanation, in this study a study will be conducted on contain of micro mineral with focus on iron (Fe), copper (Cu), and manganese (Mn) in cacao beans from the plantation and transmigration areas in East Luwu using ICP-OES. ICP-OES was chosen because measurement is quite selective and can be used to determine several elements simultaneously in the sample.

2. Experimental

2.1. Material and Methods

2.1.1. Sampling method
The fruit was sampled according to its availability in each tree in five location sampling. Cacao beans are separated from pods, and dried with air. Dried cacao beans are divided into nuts and shells (peanut layer). Furthermore, the samples were dried in an oven at 60 °C for 24 hours, milled and sieved with a 20 mesh [6].

2.1.2. Material and equipment
Materials was used in this research were HNO3 p.a. (65%, Merck), HCl p.a. (37%, Merck), tissue roll, cacao fruit (Theobroma cacao L), aquabides, sample bags, Whatman filter paper No. 42.
Equipment was used in this research include, glass tools commonly used in laboratories, furnace, oven and Inductively Coupled Plasma (ICP)- OES Perkin Elmer Optima 8300.

2.1.3. Analysis with ICP OES
Ten gram of cacao beans were weighed in a silica dish, then heated on a fire directly carefully until it was coal (the heating temperature should not be too high so that there is an incandescent). After that transfer it to the furnace for ignition at 500 °C for 2 hours. Then added 1 mL to 2 mL of aquabidest and 3 mL of nitric acid heated over the water bath and after drying, heat it on the flame carefully at a low temperature so that all the nitrate is lost. Next, the silica dish is put back into the furnace with a temperature of 525°C for 1 hour. After 1 hour, cool and dissolve the ash with 10 mL HCl while heating it and then transfer it to a 100 mL measuring flask with aquabidest and set the volume. The content of the micronutrient in each sample are determined using Inductively Coupled Plasma [7].

3. Result and discussion
The composition of the micronutrient content in the sample of cacao beans in the plantation area in East Luwu is shown in the following figure 1:
The composition of the micronutrient content in the cacao bean samples in the transmigration area in East Luwu is shown in the following figure 2:

Figure 1. Micronutrients content of cacao beans in plantation area (mg/100 g)

Figure 2. Micronutrients content of cacao beans in transmigration area (mg/100 g)

The results showed that the average copper (Cu) content in cacao beans in the plantation area and transmigration area was 2.022 mg/100 g and 2.202 mg/100 g, respectively. The average copper content from both locations has a value close to the content contained in cacao beans in Nigeria with an average of 2.61 mg/100 g dry weight. Whereas, in other studies in the Southeast Ivory Coast, higher values of Cu content in cacao beans were obtained at 3.12 mg/100 g of cacao [8]. In the body's metabolism, copper plays a special role in several respiratory enzyme activities as a cofactor for the enzyme tyrosinase and cytochrome oxidase. Copper is also needed in the process of growing young red blood cells. According to [2], Mineral essential elements for nutrition in different chocolate products. Samples analyzed for significantly higher copper content were observed in chocolate containing 90% cacao (dark chocolate) which was 2.0 mg/100 g. Thus the results of the analysis of cacao beans originating from plantation areas and transmigration areas can be recommended as raw material for food products that can contribute to the body's nutritional needs.

In this study the average content of iron (Fe) in cacao beans in the plantation area and transmigration areas was 2.683 mg/100 g and 2.022 mg/100 g, respectively. The iron content of the two regions is not
very different from the iron content of cacao at the southwestern and west point of Ivory Coast with values of 2.76 and 2.53 mg/100 g cacao, respectively [8]. Iron is an essential element whose presence must absolutely be fulfilled in plant metabolism. Iron has a vital function in the body including functioning as a carrier of oxygen to all tissues of the lungs by red blood cell hemoglobin. Iron also acts as a transportation medium for electrons in cells, and as an important part that is integrated with enzyme systems in various body tissues [9]. According to [2], mineral essential elements for nutrition in different chocolate products. The samples analyzed for iron content were observed in milk chocolate, namely 1.19 mg/100 g. Thus, cacao beans originating from plantation areas and transmigration areas can contribute to nutritional needs as raw material for food products. Based on analysis result of Fe and Cu content between plantation areas and transmigration areas, there are relation because micronutrient Fe and Cu are competing each other in the metabolic process [10]. The relation we can observe when high Fe uptake so there are deficiency of micronutrient Cu.

The average content of manganese in cacao beans in plantation areas and transmigration areas were 1.80 mg/100 g and 1.57 mg/100 g, respectively. The concentration of plantation areas and transmigration areas were not much different from the manganese content in Central America with value 2.41 mg/100 g [3]. The average amount of Mn content in food crops is the lowest of 0.13 and the highest is 11.3 mg/100 g [11]. According to [2], mineral essential elements for nutrition in different chocolate products. Manganese concentration is observed in chocolate containing 90% cacao with a value of 2.05 mg/100 g and this is in accordance with the nutritional reference value (NRV) in the European Union, which is around 102.7% NRV. Based on analysis it can be concluded that cacao beans originating from plantation and transmigration areas can be recommended as a raw material for food products that can contribute to the body's adequate nutrition. Furthermore the originality of this research is to compare of micronutrients content (Fe, Cu, Mn) in cacao beans from plantation area and transmigration area. For further research, it can be investigated the other type soil land of cacao plantation and explore more micronutrients content.

4. Conclusions
The average content of micronutrient Fe, Cu, Mn in the cacao beans from plantation area were 2.022 mg/100 g, 3.009 mg/100 g, and 1.571 mg/100 g, respectively. While in transmigration areas the concentration of Fe, Cu, Mn were 2.683 mg/100 g; 2.202 mg/100 g, and 1.801 mg/100 g, respectively. Cacao beans are rich in micronutrients and have the potential to become raw materials for food products that meet the body's nutritional adequacy.

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