VOLCANIC ASH SOIL AS THE QUALITY FEATURE OF INDONESIAN COFFEE

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Indonesia is known as the country that has the most active volcanoes (30%) in the world. Arnold (1988) stated there are more than 1,300 volcanoes in the world, half of them have historic eruptions that affect to the surrounding natural resources and the behavior of the people around them. One of the most important things from the volcanic eruption is the type of rock released during the eruption. The type of igneous rock is released by a volcano will largely determine the type and characteristics of the soil formation. Volcanic ash soil has various names in the world, in Indonesia is known as Andosols, in the USA is known as Andisols, in Japan is known as Kurobokudo, in Chile is known as Humic Allophane Soil, in Canada is known as Acid Brown Forest Soil, In New Zealand is known as Yellow-brown Pumice Soil, while in Germany is known as Andosols and Chernozem. Volcanic ash soils is one of the most fertile and productive soils compared to the others, therefore this region has a very high density of population.

In Indonesia, volcanic parent material is dominated by andesitic materials, but in general consists of four types i.e. rhyolytic, andesitic, andesitic-dacitic, and andesitic-basaltic. Andesitic materials contain a balanced composition of essential nutrients for plants such as Fe, Mg, Ca, Na, K. The study results showed that volcanic ash soil has high enough weathered mineral reserves consisting of 23% volcanic glass, 11% augit, 14% hyperstein, 8% labradorite, 3% bitownite and 1% tourmaline. Augit and hyperstein are ferromagnesian minerals that contain nutrients as carriers of aroma and taste in coffee. Other weathered minerals that are found in small amounts are epidots. The pyroclastic materials are high nutrient reserves, which if weathered will be a source of essential nutrients, especially Ca, Mg, K, Na, P, S, Fe, Mn, and B. The presence of tourmaline is very important because it is a source of Boron (B) micro nutrients which are absorbed by plants in the form of B_2O_3. The function of boron nutrient for plants is as transportation of carbohydrates in the body of plants, which improve the quality of coffee crops (Sukarman *et al*, 2014), while Anda *et al.* (2012) stated volcanic ash contains various essential nutrients needed by plants such as Ca, Mg, K, Na, P, S, Fe, and Mn. Volcanic ash soil is only found in non-coherent volcanic material at an altitude of 750 to 3,000 m in wet tropical climates with annual rainfall around 2,500-7,000 mm. The increasing elevation will effect to the C-organic, total N, C/N, and pH tend to be higher, but the available P, base saturation and cations Ca, Mg, K are lower (Sari *et al.* 2013).

Based on the sequence of topography, volcanic ash soil spread in wavy, undulating, hilly and mountainous regions. However, most of the volcanic ash soil spread over hilly to mountainous areas. Volcanic ash soil (Andosols) is widely developed in wet tropical climates with annual rainfall around 2,500 to 7,000 mm with average temperature <22 ºC, its environmental conditions are very suitable for the growth and development of coffee crop, especially Arabica coffee. Nur and Mamela (2003) stated that the production of high quality Arabica coffee beans require average temperature of 16-20ºC, RH 75-95%, annual rainfall of 2000-3000 mm and rich nutrient in volcanic ash soil. The optimum temperatures are around 15-24ºC. Ideally, 1500-2500 mm of rain will fall over a nine month period with a three month dry season coinciding with the harvest (Mitchell, 1988). While Illy and Viani (1995) stated that the optimal climate for Arabica coffee beans, in the equatorial regions are at an altitudes of 1100-2000 m with frequent rainfall. Although, recent studies showed that Andosols in Indonesia have not only developed in wet climates with rainfall as mentioned above, but it is found in areas with lower annual average rainfall, which is less than 2,000 mm with a moisture regime classified as Ustic, such as on Flores Island, East Nusa Tenggara.

In Fact, Indonesia has a lot of quality coffee that has been recognized internationally, such as Aceh Gayo, Mandailing, Sidikalang, Toraja, Bajawa Flores and many more. It is more than 15 leading coffee producing regions in Indonesia which has the best Arabica coffee comes from five mountainous regions, i.e. Wamena Arabica (Papua), Toraja Arabica (South Sulawesi), Malabar Arabica (West Java), Gayo Arabica (Aceh), Flores Arabica (NTT). Wamena Arabica is grown in the Baliem valley of the Jayawijaya Volcano, planted around the cliffs with a minimum elevation of 2,000 m. Malabar Arabica is grown around of Malabar Volcano, it is located in the southern part of Bandung Regency with the highest elevation at 2,343 m. Gayo Arabica is grown on the Gayo Plateu, which is located at one of the ridges of the Bukit Barisan mountains range that spans along the island of Sumatra. Flores Arabica comes from coffee plantations in the highlands of the Ngada Regency that is located at elevation about of 1,000 to 1,550 m, and rainfall range about 2,500 mm per year. All of five regions mentioned above are covered by volcanic ash soil (Andosols). The best coffee producing regions in Indonesia is currently only a small part of the total area of volcanic ash soil in Indonesia. Based on statistic report from Directorate General of Estate Crops (2018) showed that total area for Arabica productions in Indonesia are around 339,636 ha, while total area of volcanic ash soils in Indonesia are arround 5.4 million ha (2.9% of the total land area of Indonesia), spread on the islands of Sumatra, Java, Bali, Lombok, Flores, North Maluku and North Sulawesi, it is concluded that area of Arabica coffee production only used 6.3% of volcanic ash soil area in Indonesia.

In West Java, the total area of Arabica coffee production is around 20,106 ha, while the volcanic ash soil distribution in West Java is around 477.474 ha, it is concluded that the use of this soil for Arabica Coffee production only 4.2% recently, it shows that the potential for Arabica coffee production in West Java is still very high. Furthermore, the expansion area is only concentrated in some areas such as Bandung, West Bandung and Garut Regency, while expansion in other areas is still limited. This fact does not only occur in West Java but it may also occur in other regions of Indonesia, thus the opportunity to reach market demand of Arabica Coffee by optimizing production on volcanic ash soil are still very feasible to be done.

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