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Evaluation of levels of minerals and trace elements of Cocoa (*Theobroma cacao*) in Côte d'Ivoire.

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A B S T R A C T

Evaluate the levels of minerals and trace elements of cocoa (*Theobroma cacao*) in Côte d'Ivoire. The study focused on cocoa collected in six production areas selected according to major national production regions. The samples were collected in cloth bags cretonne for the promote good aeration. This study allowed the determination of levels minerals and trace elements by atomic absorption spectrometry (AAS). The results obtained showed that the Iron was represented in large quantities (9, 71 mg / 100 g of cocoa). Copper and Zinc were represented in small quantities respectively 3, 12 and 4, 42 mg / 100 g of cocoa. Regarding minerals, the results showed that Potassium and Phosphorus were represented in large quantities with respective maximum values of 637 and 623 mg/ 100 g of cocoa. Magnesium was represented in small quantities with a maximum value of 304 mg/ 100 g of cocoa. The cocoa of Côte d'Ivoire contains minerals and trace elements which involve systems that allow the body to fight against the harmful effect of oxidative stress and cardiovascular diseases.

Keywords: Cocoa (*Theobroma cacao),* minerals, trace elements, oxidative stress, cardiovascular diseases, Côte d'Ivoire.

A R T I C L E I N F O

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1. Introduction

Cocoa is the fermented seed and dried of the fruit of the cacao tree (*Theobroma cacao*) [1]. The Forastero variety is the most cultivated in Côte d'Ivoire. This variety is considered the ancestor of all the cocoa varieties. Its rugged design ensures very high yields, it represents about 80% of world culture [2-3]. The Côte d'Ivoire, the world's largest cocoa producer, providing about 40 % of world cocoa. It is used as antistress in hepatic dysfunction, cardiac and respiratory. Cocoa is for Côte d'Ivoire, an important economic and social sector characterized by a population estimated at 800,000 producers [4-5]. The cocoa is in the form of powder, oil which contains medicinal and nutritional properties. It is used in dysfunctions liver and of heart [6-7]. It contains many bioactive compounds whose minerals and trace elements [2]. Cocoa is a good provider minerals. Minerals are components of all body tissues. They are found in large quantities in certain structures such as bones, teeth and nails [8]. The trace elements and minerals are extremely important for the proper functioning of the body [6]. Its low acidity, makes the cocoa from Ivory Coast used a lot by chocolate manufacturers worldwide [9-10-11]. The objective of this work was to evaluate of levels of minerals and trace elements of cocoa of six areas of production of cocoa (*Theobroma cacao*) in Côte d'Ivoire in order to have a competitive cocoa and very good for the health of the consumer.

2. Materials and Methods

Sample collection

Study samples

We used cocoa beans (*Theobroma cacao*). The sampling took place in the period of May and June matching the intermediate season. The samples were collected in cloth bags cretonne for the promote good aeration.

Study areas

The study areas were production cities grouped into six areas

Area 1: South East
Area 2: South
Area 3: center
Area 4: West Central
Area 5: South West
Area 6: west

Technical equipment

The samples were analyzed at the Company's mineral analysis laboratory for the Mining Development of Côte d'Ivoire (SODEMI) in Abidjan. The study required a muffle furnace, an incubator, a dessicator, a precision balance and an atomic absorption spectrophotometer, concentrated nitric acid (HNO_3, 69 %), demineralized water and standard solutions of different minerals (Magnesium, Potassium, Phosphorus) and trace elements (Iron, Copper, Zinc).

Mineralisation

100 g of cocoa were taken in dry crucibles and heated to 105 °C in an incubator for 08 hours. The dry matter obtained was brought to 550°C in a muffle furnace for 08 hours. The crucible containing the ashes was removed and placed in a desiccator to cool to room temperature.

Assays minerals

The assays were performed by atomic absorption spectrophotometry. 1g of the ash was taken up with 2 ml of HNO_3 (69%). The mixture was transferred to plastic tubes of 50 ml and supplemented up to the gauge with demineralised water. The solution obtained is homogenized. Same time one blank for each mineral has been prepared, it consisted of demineralised water at 1%, nitric acid and the mineral from stallion to be assayed. A calibration curve resulting absorbance versus of the concentration was deduced for each sample the concentration of the element in percentage of dry matter.

Statistical analysis

The results are expressed as mean ═ SEM (Standard Error of Mean). We used the statistical programs: Stat View ® 4.01 (Mind Vision Logiciels, Concepts, Inc., Berkeley, CA, USA) and GraphPad Prism ® (version 4.00; Graph Pad Software Inc., San Diego, CA, USA).

3. Results and Discussion

Trace elements

Iron content

Figure 1 gives iron content of cocoa produced in the six areas of our study. This level is very high in zones 1 and 4 with values of 9, 71 and 8, 33 mg / 100 g of cocoa. This value is low in zones 5 and 6 with the respective values of 2, 76 and 2, 53 mg / 100 g of cocoa.

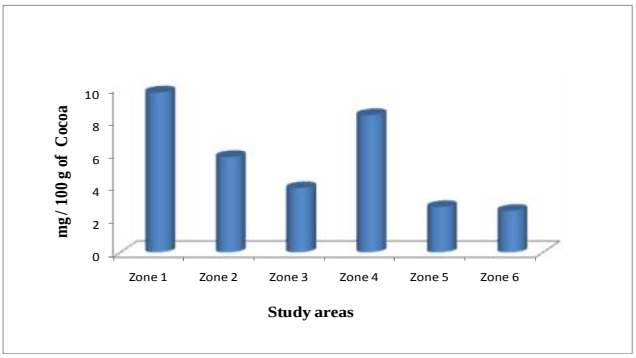

Figure 1: Iron content

Copper content

Copper content of cocoa in the six areas has a maximum value of 3, 12 mg / 100 g of cocoa in Zone 1 and the lowest value was 2, 08 mg / 100 g of cocoa in Zone 5 (**Fig. 2**).

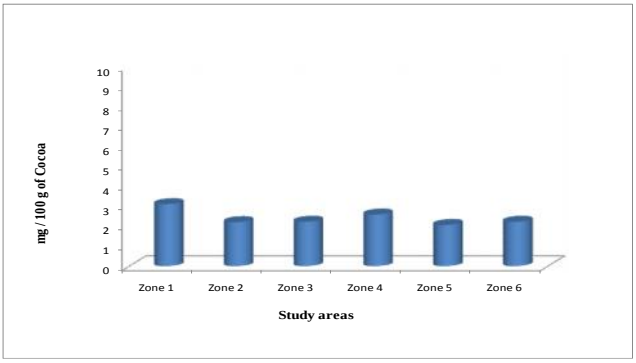

Figure 2: Copper content

Zinc content

Zinc content of the six regions is shown to figure 3. High values are found in zones 1 and 2 respectively of 4, 42 and 4, 15 mg / 100 g of cocoa. The weakest value is in zone 5, with a value of 3, 09 mg / 100 g of cocoa.

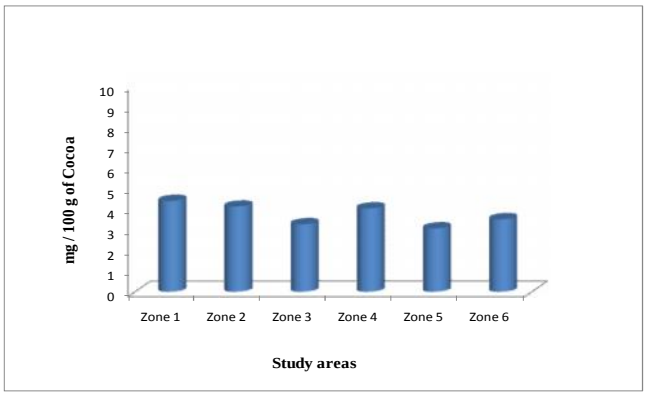

Figure 3: Zinc content

Minerals

Potassium

Figure 4 gives Potassium content of cocoa produced in the six areas of our study. This level is very high in zones 3 and 6 with values of 637 and 612 mg / 100 g of cocoa. This value is low in zones 4 and 1 with the respective values of 495 and 465 mg / 100 g of cocoa.

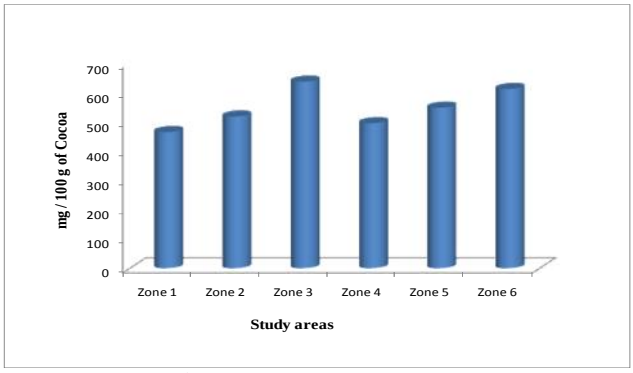

Figure 4: Potassium content

Phosphorus

Phosphorus content of cocoa in the six areas has a maximum value of 623 mg / 100 g of cocoa in Zone 5 and the lowest value was 366 mg / 100 g of cocoa in Zone 3 (**Fig. 5**).

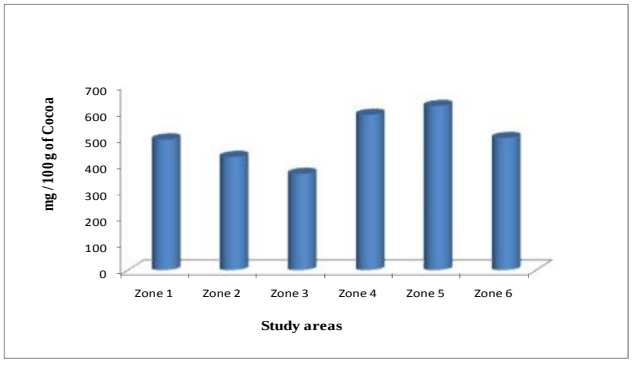

Figure 5: Phosphorus content

Magnesium

Magnesium content of the six regions is shown in figure 6. High values are found in zones 3 and 6 respectively of 304 and 298 mg / 100 g of cocoa. The weakest value is in zone 4, with a value of 243 mg / 100 g of cocoa.

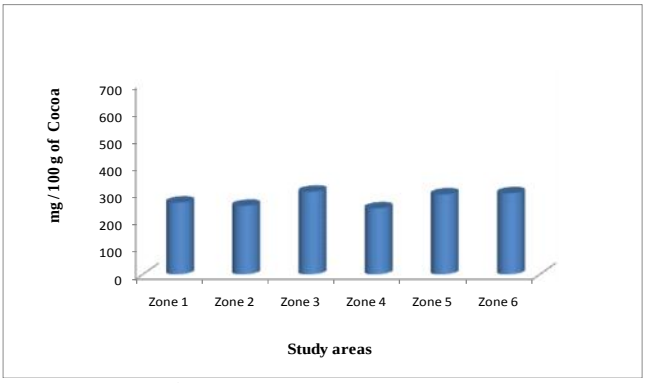

Figure 6: Magnesium content

Discussion

Our study aimed to evaluate the levels of minerals (magnesium, phosphorus and potassium) and trace elements (iron, copper and zinc) into of cocoa (*Theobroma cacao*) of producing areas in Côte d'Ivoire. The results showed that the iron was strongly represented in the cocoa with a value of 9, 71 / 100 g of cocoa (Fig.1). Trace elements such as copper and zinc are shown in small quantities with respective maximum values of 3, 12 and 4,42 mg/ 100 g of cocoa (Figs. 2;3). Regarding minerals, the results showed that Potassium and Phosphorus were represented in large quantities with respective maximum values of 637 and 623 mg/ 100 g of cocoa (Figs. 4;5). Magnesium was represented in small quantities with a maximum value of 304 mg/ 100 g of cocoa (Fig 6). Our results are consistent with the results conducted by several research teams on proportions of trace elements such as iron, copper and zinc contained in cocoa. Proportions of trace elements range between 4 and 4, 5 % [12-13]. Trace elements are not produced by the body, but in food [14]. Cocoa is consumed much in our regions, it contains trace elements that are beneficial to our body [15-16]. In our study, we showed that the iron had a high value in zone 1 with a value of 9, 71 / 100 g of cocoa. Iron is essential for the production of hemoglobin of red blood cells and at proper functioning of muscles. Iron deficiency causes anemia, source of great tiredness [17].

The low content of Iron of 2, 53 mg / 100 g of cocoa in zone 6 is due to the variability of soil [**15].** Copper is found in small quantities in the cocoa with a maximum value of 3,12 mg/ 100 g of cocoa. Cocoa is a provider of trace elements. Copper is essential for numerous reactions in the body, particularly in the digestion [**18].** A deficiency in the body Copper causes a risk of cardiovascular disease [**19].** Our results show that cocoa produced in the study areas gives a value of 4,42 mg/ 100 g of cocoa of Zinc. Zinc acts on the breath and is a vital element which acts as an antioxidant and prevents the harmful effects of free radicals [20].

Millions of people use every day chocolate, it is an energy source that contains important nutrients. Minerals Represent 5% of the cocoa mass, mainly in the form of magnesium, potassium and phosphorus [21]. However the bioavailability of these minerals may be compromised because of the presence in the chocolate of certain fibers which may interfere with the gastrointestinal absorption of these minerals [21-22]. Cocoa minerals are endowed with a modulating effect of the immune system [23]. Tonus and relaxation of the blood vessels are also important in the development of heart disease and in the regulation of blood pressure. Cocoa minerals increase the relaxation of blood vessels *in vitro* [24].

The minerals contained in cocoa would influence cardiovascular function by allowing the body to produce peroxynitrite than the body uses as a defense against pathogenic microorganisms [25]. To protect itself from this toxic effect of oxygen, the organism has developed defense systems that eliminate Free Radicals (FR). These systems consist of minerals, trace elements and proteins that prevent the iron to trigger production of Free Radicals [26-27]. Minerals and trace elements are the only molecules that can trap and neutralize Free Radicals [28]. Living organisms do not produce trace elements and minerals. They come from foods or beverages such as cocoa. These trace elements and minerals have systems that allow the body to fight against the harmful effects of oxidative stress and cardiovascular disease [29].

4. Conclusion

Our study to determine minerals and trace elements contained in cocoa (*Theobroma cacao*) produced in six areas of Côte d'Ivoire. The results showed that our cocoa contains Iron in large quantities. Copper and Zinc are represented in small quantities. Regarding minerals, the results showed that Potassium and Phosphorus were represented in large quantities. Magnesium was represented in small quantities. The cocoa of Côte d'Ivoire contains trace elements and minerals that have systems that allow the body to fight against the harmful effects of oxidative stress and cardiovascular disease.

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