Nigerian Research Journal of Chemical Sciences (ISSN: 2682-6054)
Vol. 7, Issue 2, 2019

DISTRIBUTION OF MANGANESE AND IRON IN DEPOSITED DUST FROM FOOD MILLING SHOPS IN PORT HARCOURT CITY, NIGERIA

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ABSTRACT

This study investigated the distribution of Manganese and Iron in deposited dust from food milling shops in Port Harcourt city, Nigeria, sampling five major markets. The dust samples were digested with aqua-regia mixture (HCl and HNO_3 in the ratio 3:1 v/v) and analyzed using Atomic Absorption Spectroscopy (AAS). The results showed that Mn value in samples collected from milling shops at Creek road market was with mean value 17.7±2.9 mg/kg and at Rumuokoro slaughter market with mean value 17.6±1.4 mg/kg. Fe was high in samples from Creek road market with mean value 1578±500.6 mg/kg and low in samples from Elekahia market with mean value 48.70±15.1 mg/kg. It also showed that Mn and Fe were high in the samples from millings shops. However, Fe was the most dominant metal present in samples. The findings showed that Mn and Fe are released into the atmosphere and deposited as dust through milling with fabricated machines. Fe was the most metal present because most of the fabricated machines used in milling are made of cast iron which is 95% Fe in composition. It was recommended that periodic evaluation of the metal content of the atmospheric dust deposition should be sustained to monitor future accumulation while milling shops in market places should be well ventilated.

Keywords: Deposited dust, food milling shops, Iron, Manganese

INTRODUCTION

The processing of foodstuffs in the 21st century markets using machine-based grinders to mill foodstuffs may contribute considerably to the increase in the metal-dust load of the environment. Manganese (Mn) and Iron (Fe) are examples of heavy metals because of their high specific gravity. Since they are toxic at high concentrations, their presence in the environment in dust becomes a threat [1, 2]. The mobilization of heavy metals into the biosphere by human activities has become an important process in the geochemical recycling of these metals, thus enabling them to stay long in the environment. Pollution of the natural environment by heavy metals is a worldwide problem because these metals are indestructible and most of them have toxic effects on living organisms. While some of these elements are essential for humans, at high levels they can also become toxic [2]. The particles of dust that deposits from the milling of foods and accumulate along the walls or on other materials in the milling shops are deposited dust [3]. Dust represents complex chemical composition and originates from the interaction of solid, liquid and gaseous materials produced from different sources and activities [4, 5]. Dust has been implicated to have the potential to carry high loading of contaminant species such as heavy metals and organic pollutants of the sources' compositions [6]. Dust are useful indicators of the level and distribution of heavy metal contamination in the surface environment [7, 8]. Milling shop workers and users are constantly exposed to deposited dust, which may affect their health at an intense intake. This is because at milling shops people queue up and with less ventilation, they are exposed to dust throughout their working hours.Increasingly, particles emitted from dust poses threat to human health and the environment. Interest on the effects of atmospheric particulates on health and environment has increased many folds based on evidence that this type of pollution proved a strong link with respiratory diseases. Deposited dust on humans is better appreciated if one considers the fact that an active person typically inhales this dust in the air daily. Apart from direct health problem on man, the adverse effect of the distributed metals in deposited dust is in the capability to contaminate foodstuffs in other side shops and the immediate environment [2]. There have been extensive studies on heavy metal contamination of dust in urban areas, streets and classrooms, while no or little researches have been conducted on the distribution of heavy metals (Manganese and Iron) in milling shops in markets.Hence the investigation of the distribution of Manganese and Iron content in deposited dust from milling shops in Port Harcourt City markets because deposited dustmay contain particles of these metals which are toxic to both human health and the environment.In the present study, an attempt has been made to evaluate levels of Manganese and Iron distributions in deposited dust from food milling shops. The study would form the basis of establishing baseline data regarding Manganese and Iron contents in deposited dust from food milling shops.

MATERIALS AND METHODS

Study Area Description

Port Harcourt is the capital and largest city of Rivers State, Nigeria. It lies along the Bonny River and is located in the Niger Delta. Port-Harcourt city is made up of the local government areas itself and parts of Obio-Akpor. Port-Harcourt is highly congested as it is the only major city of the state.

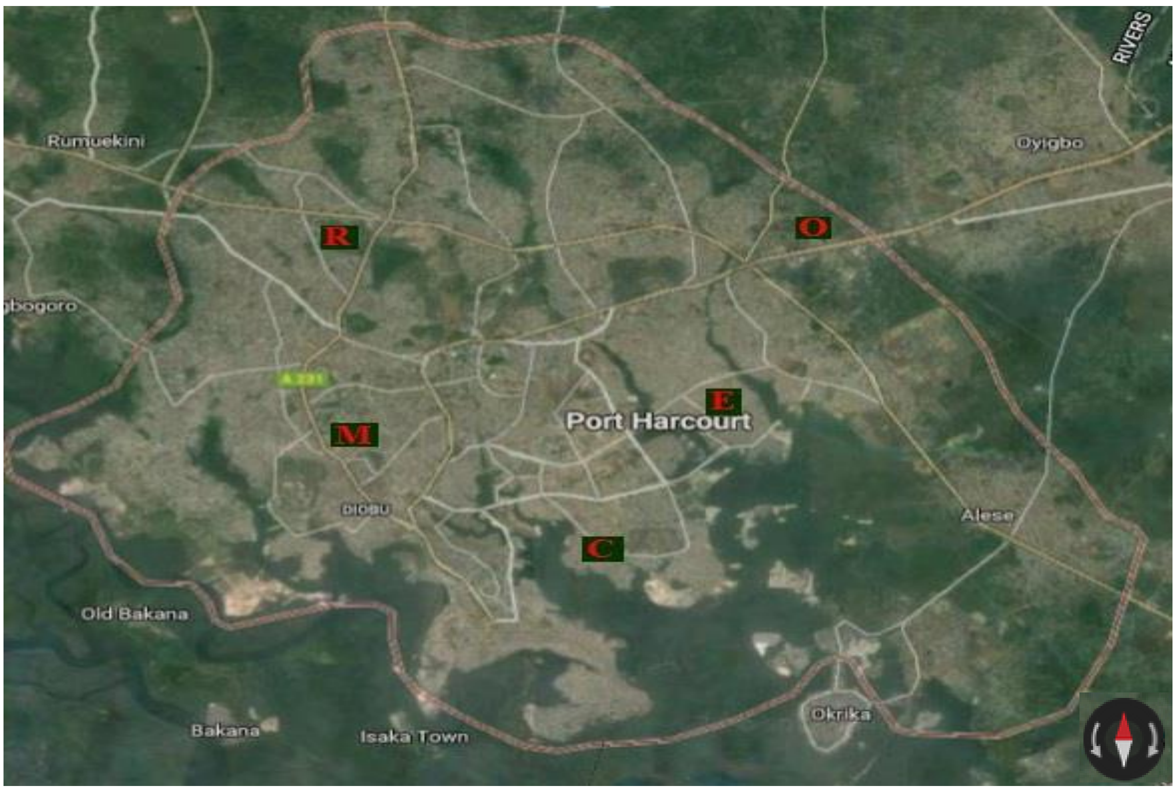

Figure 1: Map showing different sample sites in Port-Harcourt City

Legend

E = Location of Elekahia Market,

M = Location of Mile 1 Market

C = Location of Creek road Market,

O = Location of Oilmill Market

R = Location of Rumuokoro Slaughter Market

Table 1: Study Sites and Sampling Details

Sample Code	Description of Sample Point	Sample Collected
C	Creek Road Market	Dust from milling shop
M	Mile 1 Market	Dust from milling shop
O	Oilmill Market	Dust from milling shop
E	Elekahia Market	Dust from milling shop
Z	Elekahia Market (Control 1)	Dust away from milling shop
Y	Oilmill Market (Control 2)	Dust away from milling shop
R	Rumuokoro Slaughter Market	Dust from milling shop

Sample Collection

The study was designed to collect samples from Markets in PortHarcourt City. Randomly, five major markets were selected. Seven samples were collected from five sampling sites-Creek Road Market, Mile 1 Market, Oilmill Market, Elekahia Market and Rumuokoro Slaughter Market, at Elekahia and Oilmill samples were collected away from milling shops and from the milling shops, other markets samples were collected from the milling shops. The dust samples were collected with a dustpan and brushes by sweeping the surface of the walls of the shops where these dust have long been deposited in each sampling site and stored in plastic sampling bottles.

Sample Preparation and Digestion

The dust samples were air-dried and weighed in triplicates. The samples were digested according to the method described by the Association of Official Analytical Chemist (AOAC) [9]. About 0.5 g of the dust samples each were weighed into weighing bottles and transferred into each of the labelled boiling tubes, 20 ml of the aqua-regia mixture (HCl and HNO_3 in the ratio 3:1 v/v) was added to each of the samples and stirred. They were evaporated on a hot plate in the fume cupboard until the black fume disappeared leaving only the white fume for 2 hours. The digested samples were allowed to cool, and were filtered into volumetric flasks respectively. For each batch, digestion reagent blanks were also prepared. The filtrate of each sample was transferred into 100 ml volumetric flask and then made up to mark with deionized water, and transferred into clean plastic sample bottles, for AAS analysis.

Data Analysis

Data generated from triplicate analyses were subjected to treatment of mean and standard deviation using SPSS version 23.

RESULTS AND DISCUSSION

Results from the study are presented in th figures below. Figure 2 shows the concentrations of Manganese and Iron in the samples and the control; and Figure 3 shows the differences in the concentrations of Mn and Fe.

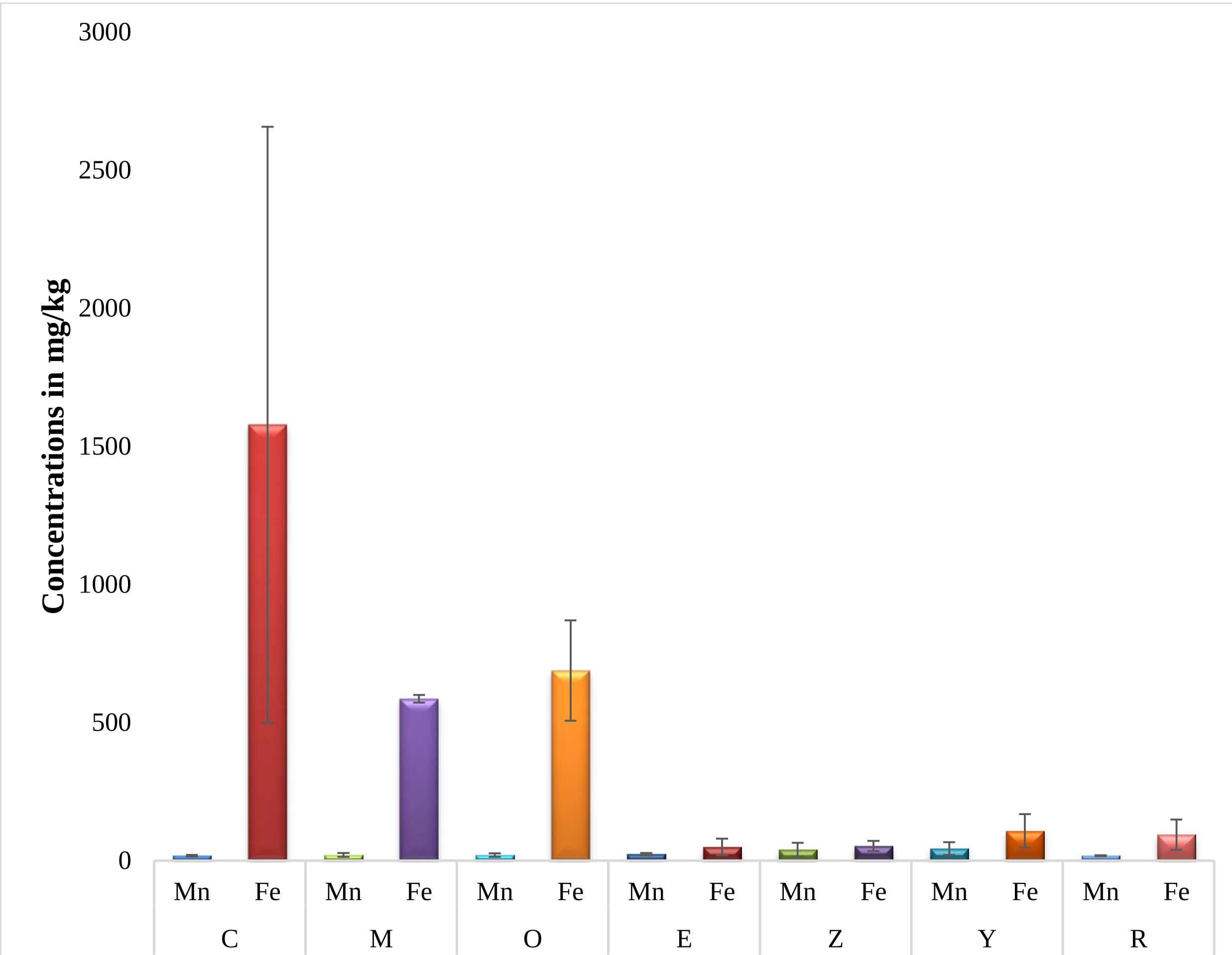

Figure 2: Concentration of Mn and Fe in Samples at different Locations

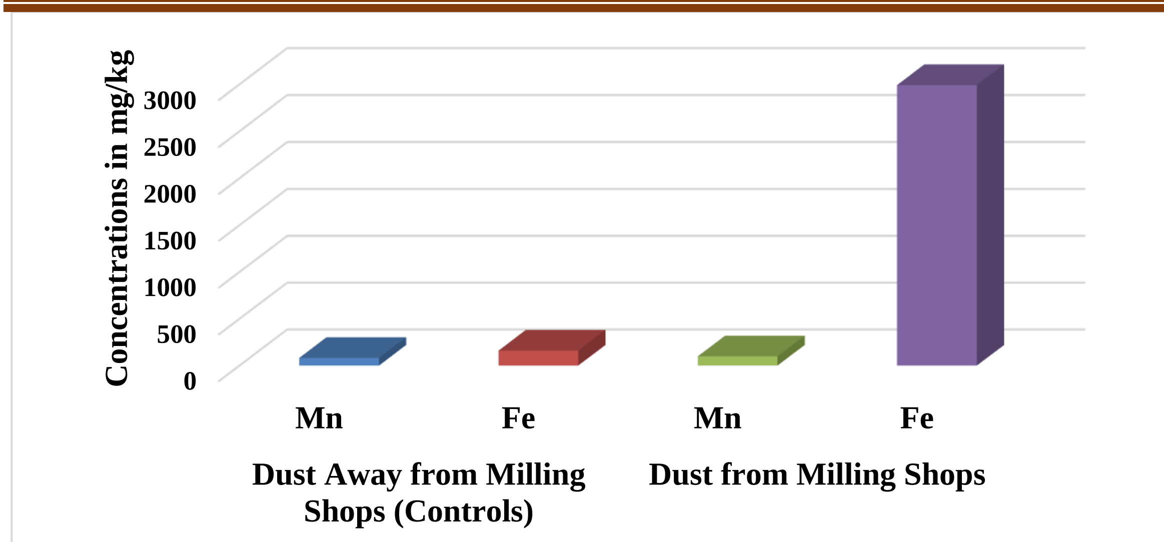

Figure 3: Variations of Mn and Fe levels

The distributions of Mn and Fe in deposited dust from milling shops are presented in Figure 2. Mn was high in the control samples at Elekahia market and Oilmill market with mean values of 43.3±22.9 mg/kg and 38.9±24.8 mg/kg respectively. It was low in samples collected from milling shops at Creek road market with mean value of 17.7±2.9 mg/kg and at Rumuokoro slaughter market with mean value of 17.6±1.4 mg/kg. Fe was high in samples from Creek road market with mean value of 1578±500.6 mg/kg and low in samples from Elekahia market with mean value of 48.70±15.1 mg/kg. Figure 3 showed that Mn and Fe were high in the samples from millings shops. However, Fe was the most dominant metal present in the samples. Cumulatively, the values obtained for Mn and Fe were higher than the control values.Fe in the samples is dependent on the elemental composition of the grinding discs of the milling machines [10]. Ronald & Daniel reported that various metals such as Mn and Fe among others are used in the manufacture of most processing devices [11]. The value of the mean concentration of Mn and Fe in dust sampling sites were in the order Creek road market>Mile 1 market>Oilmill market>Rumuokoro slaughter market>Elekahia market for Fe and Oilmill market>Elekahia market>Mile 1 market> Creek road market> Rumuokoro slaughter market for Mn. The dominance of the metals was in the order Fe>>>Mn.

Kim *et al*. [12] have revealed in their studies that dusts from markets are enriched with heavy metals. Lu *et al.* [13] and Awofolu [14] have also indicated in their studies that the source of Mn in samples may originate from industrial activities and automotive emissions. The findings from the present study for Mn agree with the studies of Abah *et al*. [15] and Addo *et al*. [2] that Mn is present in dust collected within urban areas. The present findings are in variance with the studies of Yonfu *et al*. [16] and Popoola *et al*. [1] on the account of the concentrations of Mn in dust. The high concentrations of Fe in the samples could be attributed to the abrasive friction of the grinding disc during grinding resulting in its chipping off [17]. The high concentrations of Fe agree with the finding of Kalagbor *et al*. [18] on how milling could introduce metals into food. This is so because, in the manufacture of the grinding discs of the milling machines, Fe is used due to its strength and durability. Milling using the locally fabricated mill increases the Fe content in dust due to ageing and wearing of the grinding discs. Findings from the present study for the concentration of Fe agree with the studies of Yahaya *et al*. [19], Oyekale *et al*. [20] and Kalagbor *et al*. [17] on the fact that milling machines introduce particles of the metal they are made of into food sampled during milling. Logically, if Fe is introduced into foods milled with milling machines, then the Fe can be eventually distributed in the dust by electrostatic deposition. Notably, the levels of Mn and Fe recorded in this study were significantly higher than the control.

CONCLUSION

This study investigated the distribution of Manganese and Iron in seven dust samples obtained from five major markets in Port-Harcourt city. The findings showed that Mn and Fe were present in deposited dust from food milling shops. The study revealed that Fe was the most dominant metal compared to Mn in the samples.

RECOMMENDATIONS

It is recommended that periodic evaluation of the trace metals content of the atmospheric dust deposition should be sustained to monitor future accumulation. Furthermore, milling shops in market places should be well ventilated to reduce the accumulation of deposited dust in the shop. These will go a long way in reducing human exposures to some contaminant-bearing dusts emitted into the atmosphere through anthropogenic activities like milling with locally fabricated milling machines.

ACKNOWLEDGEMENT

We thank Dr. J. L. Konne, Mr. D. Beekee, Mr. F. Tosin, Mr G. Mandy, Mr W. Kate, Dr. M. T. Yobe and Mr. B. P. Nnaa for their assistance in various capacities during the course of this research.

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