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QUALITATIVE ANALYSIS OF GLASS FIBRE FILTER AND RESPIRABLE FOAM USING X-RAY FLUORESCENCE

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Abstract. *The Aerosols were captured using SKC Air Check high volume gravimetric Sampler and respirable foam for I.O.M sampler. The trace elements in the glass fibre filter and the respirable foam: K, Ca, Ti, Ar, Fe, Cu, Zn, Sr, Zr, V and Ni were analyzed by using X –Ray Fluorescence. The mean concentrations of the trace elements in glass fibre filter (PM10) are; K,0.0824 ppm, Ca,0.051ppm, Ti,0.308 ppm, Ar,0.0716ppm, Fe,0.00129 ppm, Cu,0.00018 ppm, Zn,0.037 ppm, Sr,0.014 ppm, Zr,0.0123 ppm, V,0.00489 ppm, Ni,0.00049 ppm. The mean concentrations of the heavy metal in the respirable foam (PM2.5) are; K,0 .0354 ppm, Ca,0.0096 ppm, Ti, 0.235 ppm, Ar, 0.067 ppm, Fe, 0.00175 ppm, Cu, 0.0000756 ppm, Zn, 0.0226 ppm, Sr, 0.0133 ppm, Zr,0.127 ppm, V 0.0052 ppm, Ni,0.00040 ppm. The mean concentrations of the heavy metal obtained in this analysis were below the available regulatory limits.*

Key words: *Aerosols, Trace elements, Benin City, Sawmill, X-Ray fluorescence*

1. INTRODUCTION

Aerosol monitoring has heightened over the past decade mainly because of their pernicious effect on climate and health. African dust and natural dust resuspension contribute immensely to the concentration of particulate matter in the atmospheric (Artinano et al., 2004; Ediagbonya et al., 2013b; 2014c). Particulate matter can be classified into particle sizes, Biological, shapes and chemical species. The pernicious effect of chemical species and particle sizes cannot be over-emphasized. Tsai and Cherg studied how the chemical composition of particulate matter varied in different air quality condition in the coastal area (Tsai and Cheng, 1999). There is strong proof that particle chemical composition influences toxicity (Laden et al 2000). Particle size has been shown to have a major influence upon toxicity in vitro test systems and to be related to adverse effects of ambient air (Dick et al., 2003; Anderson et al 2001; Ediagbonya et al., 2015). Consequently, the study is designed to determine the trace metal in respirable and

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inhalable components of the suspended particulate matter in a typical rural community in Nigeria and also to compute the enrichment factor. The large contribution of the regional secondary aerosol to PM10 (Inhalable particle concentration have been observed in other part of the world (Memmesheimer et al., 2004; Lenschow et al., 2001; Gehria and Buchmann, 2003; Bessagnet et al., 2005; Ediagbonya et al., 2014a). Trace exposure to fine fraction (respirable particle and less are retained in the alveolar regions of the lungs and are able to diffuse into the blood circulation and may subsequently induce inflammation oxidative stress and increased coagulation of blood (Seaton et al., 1995; Ediagbonya et al., 2014b). Furthermore, in order to understand the public health implications and assess exposure risks, chemical components of a particulate pollution must be known. The objectives of this paper are to provide some background information on the environmental chemistry of trace metals; spatial distribution of the trace metal of inhalable and respirable and finally compare the mean concentration of the trace metals with the regulatory limit.

2. Materials and Methods

2.1. Area of study

The study areas are Egor, Ikpoba-Okha and Oredo Local Government Areas that make up the metropolitan city of Benin, the capital of Edo State. It is situated in the tropical rain forest belt and at 122 m above sea level. The inhabitants are mainly Benin-speaking people. The people are combination of Christians, Moslems and traditional African worshippers. The total size of forest reserves in Benin City is about 357.42 km2; however, the Local Governments have free forest zones implying that individuals do not have to collect permits from government to fell trees in these forests. There are about 32 registered sawmills in the Local Government Area, all privately owned, and belonging to a trade organization "Saw millers Association" and under a central government regulatory body-the Edo State Forest Resources Management Association. A typical sawmill is a large shed with a proof made of old corrugated zinc and bare floor covered with several layers of sawdust, and supported by 6 - 8 wooden poles. The open shed houses a giant electrically driven band saw, and a circular saw mounted on a fabricated metal table. An office and a storage yard for products (sawn wood) may be built by adjoining the mill. Fresh logs are usually seen lying in the open yard. Sawdust piles surround the machines and may also be kept in a waste dump on the premises, awaiting disposal, usually by burning. There are on the average 10 - 14 staff at each mill, and categories of staff includes a manager, band mill operator with 2 helpers, 2 jack men who use locally constructed jacks to move the fresh logs to the milling machine, an Edger (head rig operator) and 2 helps, 1 - 2 packers, a "saw doctor" and 1 - 2 loaders.

2.2. Ambient air sampling and analytical procedure

SKC Air check XR 5000 High volume Gravimetric Sampler Model 210-5000 serial No 20537 and the I.O.M multi fraction dust sampler (Institute of Occupational Medicine) were used in this study. Details of the capturing of the particulate matter had been reported by Ediagbonya et al., 2013a; Ediagbonya et al., 2014c.

2.3. Sample preparation and measurement for XRF analysis

The elemental analysis of the glass fibre filter paper was performed using the Energy Dispersive X-ray Fluorescence (EDXRF) spectrometer. X-ray fluorescence spectroscopy can be used to determine all elements with atomic weights from 11(sodium) to 92(uranium) (US EPA, 1999). XRF technique is non-destructive and requires minimal sample preparation, the filter paper can be inserted directly into the instrument for, the detection limits are normally higher than other analysis technique with sensitivity in the range of 10-8 .X-ray fluorescence (XRF) analysis is very powerful method to determine elements in airborne particulate matter collected onto filters. The sample on the filter is irradiated with a beam of X-rays. This primary radiation interacts with the elements in the sample to produce vacancies in the inner atomic shells, which then de-excite to produce characteristic secondary X-ray radiation. The wavelengths detected indicate which types of elements are present, and the quantity is determined from the intensity of the X-rays at each characteristic wavelength (US EPA, 1999). The instrument consists of X-ray source, sample holder, detector, and current and voltage amplifier. Each glass fiber filter paper and the respirable foam was inserted into the sample holder of the XRF system and bombarded by X-ray fluorescence spectrometer with a silver (Ag) anode at a voltage of 25 kV and a current of 50 μA for 1000 counts or approximately 18 minutes in an external chamber set up. The X-Ray Detector is a Model XR-100CR, high-performance thermoelectrically cooled Si-PIN photodiode, with a preamplifier. The detector is powered by the PX2 CR Power supply, which includes a spectroscopy grade Shaping Amplifier.

3. Results and Discussion

The minimum, maximum and mean values for the levels of trace metals in inhalable particle (PM10) and respirable aerosol (PM2.5) were presented in Table 1 and 2 while the results of the Duncan Multiple Range Test for inhalable particle (PM10) and respirable aerosol (PM2.5) trace elements were presented in Tables 3 and 4 respectively. In inhalable aerosol sample, the concentration of K ranged between 0.001 – 0.306 ppm with the mean value of 0.0824±0.068 ppm, Ca ranged between 0.0062 – 0.129 ppm with the mean value of 0.051±0.0338 ppm (Table1). Calcium poses few serious environmental problems, with kidney stones the most common side-effect in clinical studies (ITII, 1998) concentrations are also high in comparison with literature values for La Plata, Argentina (Bilos et al., 2001). Lower values of Ca concentration were reported in aerosol samples collected over the China Sea (Ruojie et al., 2015). Ti ranged between 0.1 – 0.527 ppm with the mean value of 0.308±0.103 ppm, breathing in large amounts of titanium tetrachloride can injure the lungs seriously enough to cause death. After short-term exposure to titanium tetrachloride, less serious respiratory system effects can include coughing and tightness in the chest. More severe effects can include chemical bronchitis or pneumonia, and congestion of the mucous membranes of the upper respiratory tract. These effects can cause long-term effects such as the narrowing of the vocal cords, windpipe, and upper airways. Titanium tetrachloride can be highly irritating to the mucous membranes (including the upper respiratory tract), the skin, and the eyes (Mogilevskaja 1983). Argon (Ar) is used in various types of arc welding such as gas metal arc welding and gas tungsten arc welding, it is used in growing crystals of silicon and germanium, poultry industry to asphyxiate birds either for mass killing, following disease outbreaks, and to extinguish

fires. In wine making, it is used in variety of activities to provide a barrier against oxygen both microbial metabolism. Argon is also available in aerosol-type cans, which may be used to preserve compounds such as varnish, polyurethane, and paints for storage after opening. However, a death had been reported as a result of argon exposure, Ar ranged between 0.032 – 0.094 ppm with the mean value of 0.0716±0.015 ppm. Fe ranged between 0.0001 – 0.0031 ppm with the mean value of 0.0013±0.001 ppm. Cu ranged between 0.0001 – 0.0003ppm with the mean value of 0.0002±0.0001 ppm, Copper associated with particulate matter is emitted into the air naturally from windblown dust, volcanoes, and anthropogenic sources, the largest of which are being primary copper smelters and ore processing facilities. The concentration of copper in emissions from copper smelters has been found to range between 7 and 137.8 ng/m3 (Tiita et al., 2002). Other sources of copper release into the environment originate from domestic waste water, combustion processes, wood production, phosphate fertilizer production, and natural sources (e.g., windblown dust, volcanoes, decaying vegetation, forest fires, sea spray, etc.) Cu levels are higher than the reported values for many industrial areas such as Chicago (Sweet et al., 1993), Tito Scalo, Italia (Ragosta et al., 2002). Zn ranged between 0.0123 – 0.234 ppm with the mean value of 0.037±0.053ppm, Anthropogenic releases of zinc and its compounds to the atmosphere are from dust and fumes from mining, zinc production facilities, processing of zinc-bearing raw materials (e.g., lead smelters), brass works, coal and fuel combustion, refuse incineration, and iron and steel production (EPA 1980d;). Zinc is found in the atmosphere at the highest concentrations in the smallest particles (Fishbein 1981). Sr ranged between 0.011 – 0.0191ppm with the mean value of 0.0141±0.002 ppm. Most of the strontium in air is in the form of stable strontium. Very small dust particles of stable and radioactive strontium in the air fall out of the air onto surface water, plant surfaces, and soil either by themselves or when rain or snow falls. (Federman and Sachter 1997). Strontium is found nearly everywhere in small amounts, and you can be exposed to low levels of strontium by breathing air, eating food, drinking water, or accidentally eating soil or dust that contains strontium. However, it has been reported that strontium has detrimental effect on animal and one case report of a woman exposed to an undetermined concentration of strontium mixed with other chemicals in smoke from an ignited flare (Gillett et al. 1987; Jones et al. 1976). Zr ranged between 0.0141 – 0.222ppm with the mean value of 0.0123±0.0143 ppm, Short term exposure to Zirconium powder can cause irritation, but contact with the eyes requires medical attention (Lee et al., 2010). Persistent exposure to zirconium tetrachloride resulted in increased mortality in rats and guinea pigs and decrease of blood hemoglobin and red blood cell in dog (Lee et al., 2010). V ranged between 0.001 – 0.040ppm with the mean value of 0.0049±0.009 ppm. The concentrations of vanadium in workplace air (0.01–60 mg/m3) are much higher than those in the general environment. Most of the clinical symptoms reported reflect irritation effects of vanadium on the upper respiratory tract, except at higher concentrations (above 1 mg vanadiumper m3), when more serious effects on the lower respiratory tract are observed. Clinical symptoms of acute exposure are reported (Lees, 1980). Ni ranged between 0.0001 – 0.0042ppm with the mean value of 0.0049±0.009 ppm. (Table1). Exposure to nickel levels of 10–100 mg/m3 have been recorded for occupational groups, with documented increased cancer risk. Exposure levels in the refining industry are currently usually less than 1–2 mg/m3, often less than 0.5 mg/m3. Allergic skin reactions are the most common health effect of nickel, affecting about 2% of the male and 11% of the female population. Work-related exposure in the nickel-refining industry has been documented to cause an increased risk of lung and nasal

cancers. Inhalation of a mixture of oxides, sulfidic and soluble nickel compounds at concentrations higher than 0.5 mg/m3, often considerably higher, for many years has been reported (Report on International Committee on Nickel,1990) The key criterion for assessing the risk of nickel exposure is its carcinogenic potential.

Table 1 Range and Mean of Inhalable trace elements concentration in aerosol (ppm)

Elements	Min	Max	Mean± SD	WHO
K	0.001	0.306	0.0824 ± 0.068	-
Ca	0.0062	0.129	0.051 ± 0.0338	-
Ti	0.1	0.527	0.308 ± 0.103	-
Ar	0.032	0.094	0.0716 ± 0.015	-
Fe	0.0001	0.0031	0.0013 ± 0.001	2.2ppm
Cu	0.0001	0.0003	0.0002 ± 0.0001	0.038ppm
Zn	0.0123	0.234	0.037 ± 0.053	1.87ppm
Sr	0.011	0.0191	0.0141 ± 0.002	-
Zr	0.0114	0.222	0.0123 ± 0.0143	1.34ppm
V	0.001	0.040	0.0049 ± 0.009	0.024ppm
Ni	0.0001	0.0042	0.00049 ± 0.000075	0.41ppm

In respirable aerosol sample, the concentration K ranged between 0.0084 – 0.120 ppm with the mean value of 0.0354±0.0279 ppm, Ca ranged between 0.0032 – 0.032 ppm with the mean value of 0.0096±0.006 ppm (Table 2). Higher values of Ca were recorded in previous study (Sabrina et al., 2014). Ti ranged between 0.020 – 0.456 ppm with the mean value of 0.235±0.098 ppm, Ar ranged between 0.008 – 0.1006 ppm with the mean value of 0.067±0.023 ppm, Fe ranged between 0.0001 – 0.012 ppm with the mean value of 0.0018±0.003 ppm, Cu ranged between 0.00002 – 0.00014ppm with the mean value of 0.00006±0.00003 ppm, Zn ranged between 0.0111 – 0.0187 ppm with the mean value of 0.0226±0.031ppm, Sr ranged between 0.009 – 0.0171ppm with the mean value of 0.0133±0.0019 ppm, Zr ranged between 0.084 – 0.205 ppm with the mean value of 0.127±0.029 ppm, V ranged between 0.001 – 0.0333ppm with the mean value of 0.0052±0.008 ppm, Ni ranged between 0.0001 – 0.00076 ppm with the mean value of 0.0049±0.009 ppm.(Table 2).

Table 2 Range of Respirable trace elements concentration in aerosol (ppm)

Elements	Min	Max	Mean±SD	WHO
K	0.0084	0.120	0.0354 ± 0.0279	-
Ca	0.0032	0.030	0.0096 ± 0.006	-
Ti	0.020	0.456	0.235 ± 0.098	-
Ar	0.008	0.1006	0.067 ± 0.023	-
Fe	0.0001	0.0120	0.0018 ± 0.003	2.2ppm
Cu	0.00002	0.00014	0.00006 ± 0.00003	0.038ppm
Zn	0.0111	0.187	0.0226 ± 0.031	1.87ppm
Sr	0.009	0.0171	0.0133 ± 0.0019	-
Zr	0.084	0.205	0.127 ± 0.029	1.34ppm
V	0.001	0.0333	0.0004 ± 0.002	0.024ppm
Ni	0.0001	0.00076	0.0004 ± 0.002	0.41ppm

The inhalable trace elements concentration pattern in aerosol is different from the respirable samples. There was no significant difference in concentration of Ti, Ar, Zn, and Sr in inhalable aerosol samples collected from all locations and the control site (Table 3). The K concentration varied widely with significantly high ($P \leq 0.05$) concentration recorded in aerosol samples collected from Ekewan with mean value of 0.205±0.10 ppm. Significantly high ($P \leq 0.05$) values of Ca, Zr, V and Ni were recorded in aerosol samples collected from Federal with concentration values of 0.0957±0.10 ppm, 0.181±0.04 ppm, 0.0301±0.01 ppm and 0.00217±0.00 ppm respectively. Aerosol samples collected from Ogida show a significantly high value of Fe with values 0.002±0.00 ppm.

Table 3 Inhalable trace elements concentration in aerosol (ppm) from different locations

Locations	K	Ca	Ti	Ar	Fe	Cu	Zn	Sr	Zr	V	Ni
Ogida	0.082 ± 0.01^{abc}	0.0325 ± 0.01^{abcd}	0.327 ± 0.11^{a}	0.0737 ± 0.01^{a}	0.002 ± 0.00^{c}	0.000138 ± 0.00^{a}	0.0177 ± 0.00^{a}	0.013 ± 0.00^{a}	0.141 ± 0.02^{abc}	0.002 ± 0.00^{a}	4.00^{E}-07 ± 0.00^{a}
Egor	0.125 ± 0.01^{bcd}	0.0536 ± 0.01^{bcde}	0.324 ± 0.11^{a}	0.0657 ± 0.01^{a}	0.00144 ± 0.00^{bc}	0.000186 ± 0.00^{ab}	0.0197 ± 0.00^{a}	0.0143 ± 0.00^{a}	0.0872 ± 0.06^{a}	0.00215 ± 0.00^{a}	3.00^{E}-04 ± 0.00^{a}
Ekewan	0.205 ± 0.10^{d}	0.087 ± 0.06^{ef}	0.322 ± 0.11^{a}	0.0741 ± 0.01^{a}	0.00143 ± 0.00^{bc}	2.16^{E}-04 ± 0.00^{ab}	0.0247 ± 0.00^{a}	0.0158 ± 0.00^{a}	0.104 ± 0.00^{ab}	0.00165 ± 0.00^{a}	3.00^{E}-04 ± 0.00^{a}
Oluku	0.073 ± 0.01^{abc}	0.067 ± 0.01^{cdef}	0.314 ± 0.10^{a}	0.082 ± 0.01^{a}	0.00125 ± 0.00^{b}	0.000176 ± 0.00^{ab}	0.0189 ± 0.00^{a}	0.01435 ± 0.00^{a}	0.101 ± 0.00^{ab}	0.00213 ± 0.00^{a}	3.00^{E}-04 ± 0.00^{a}
Upper	0.04 ± 0.01^{ab}	0.054 ± 0.01^{bcde}	0.341 ± 0.11^{a}	0.0712 ± 0.01^{a}	0.00137 ± 0.00^{bc}	1.76^{E}-04 ± 0.00^{ab}	0.023 ± 0.01^{a}	0.0154 ± 0.00^{a}	0.114 ± 0.01^{ab}	0.0025 ± 0.00^{a}	3.00^{E}-04 ± 0.00^{a}
Dumez	0.071 ± 0.10^{abc}	0.0134 ± 0.00^{a}	0.234 ± 0.06^{a}	0.0704 ± 0.02^{a}	0.00109 ± 0.00^{b}	1.69^{E}-04 ± 0.00^{a}	0.0169 ± 0.00^{a}	0.0123 ± 0.00^{a}	0.0785 ± 0.06^{a}	0.00201 ± 0.00^{a}	3.33^{E}-04 ± 0.00^{a}
Uwugola	0.018 ± 0.00^{a}	0.0073 ± 0.00^{a}	0.348 ± 0.16^{a}	0.0722 ± 0.02^{a}	0.00129 ± 0.00^{b}	1.49^{E}-04 ± 0.00^{ab}	0.0172 ± 0.00^{a}	0.0121 ± 0.00^{a}	0.142 ± 0.02^{abc}	0.00215 ± 0.00^{a}	3.23^{E}-04 ± 0.00^{a}
Eyan	0.0377 ± 0.01^{a}	0.0734 ± 0.01^{def}	0.357 ± 0.11^{a}	0.083 ± 0.01^{a}	0.00169 ± 0.00^{bc}	2.02^{E}-04 ± 0.00^{a}	0.02575 ± 0.00^{a}	0.015 ± 0.00^{a}	0.161 ± 0.03^{bc}	0.00269 ± 0.00^{a}	3.00^{E}-04 ± 00^{a}
Federal	0.152 ± 0.01^{cd}	0.0957 ± 0.01^{f}	0.317 ± 0.11^{a}	0.081 ± 0.01^{a}	0.00123 ± 0.00^{b}	1.75^{E}-04 ± 0.00^{ab}	0.193 ± 0.04^{a}	0.0148 ± 0.00^{a}	0.181 ± 0.04^{c}	0.0301± 0.01^{b}	0.00217 ± 0.00^{b}
Control	0.02 ± 0.01^{a}	0.03 ± 0.01^{abc}	0.199 ± 0.10^{a}	0.0431 ± 0.01^{a}	0.0001333 ± 0.00^{a}	1.47^{E}-04 ± 0.00^{a}	0.0145 ± 0.00^{a}	0.013 ± 0.00^{a}	0.12 ± 0.01^{abc}	0.00147 ± 0.00^{a}	2.33^{E}-04 ± 0.00^{a}

Means with the same subscript down the column are not significantly different according to Duncan's Multiple Range Test ($P \leq 0.05$). Among the elements determined from respirable aerosol samples, significantly high (($P \leq 0.05$) K concentration value were recorded in Oluku and Ogida with the mean values of 0.0627±0.01 ppm and 0.053±0.01 ppm respectively (Table 4). Aerosol samples collected from Federal show a significantly high concentration of Ca with value of 0.02±0.01 ppm. The Ti concentration in aerosol was significantly higher in Egor area with value of 0.345±0.11 ppm, however, values obtained from upper and Eyan were slightly lower but the difference is not significant. There was no significant difference in Ar concentration in aerosol samples collected from Federal and the control site. Iron concentration recorded from aerosol samples collected from Dumez and Federal were not significantly different from one another but

significantly higher values were obtained from other locations. Highest Cu concentration value of 7.30E-05±0.0 ppm was recorded from aerosol samples collected from Eyan. There was no significant difference in concentration of Zn recorded from all locations. Sr concentration was significantly high in aerosol samples collected from Upper, Eyan and Federal area. Zr concentration was significantly higher in Federal and Eyan with the mean values of 0.183±0.02 ppm and 0.1643±0.01 ppm respectively. Vanadium concentration was significantly higher in Upper area with the mean value of 0.0289±0.00 ppm. Ni concentration was significantly higher in Oluku with the mean value of 6.44E-04±0.00ppm.

Table 4 Respirable trace elements concentration in aerosol (ppm) from different locations

Locations	K	Ca	Ti	Ar	Fe	Cu	Zn	Sr	Zr	V	Ni
Ogida	0.053 ± 0.01^{c}	0.00538 ± 0.00^{ab}	0.241 ± 0.02^{bcd}	0.0746 ± 0.01^{b}	6.749 ± 0.00^{ab}	3.80^{E}-05 ± 0.00^{ab}	0.0726 ± 0.10^{a}	0.011 ± 0.00^{ab}	0.132 ± 0.01^{c}	0.00188 ± 0.00^{a}	5.77^{E}-04 ± 0.00^{ef}
Egor	0.1004 ± 0.02^{d}	0.0117 ± 0.00^{bc}	0.345 ± 0.11^{d}	0.0765 ± 0.01^{b}	9.24^{E}-04 ± 0.00^{ab}	5.90^{E}-05 ± 0.00^{bcd}	0.017 ± 0.00^{a}	0.0124 ± 0.00^{abc}	0.123 ± 0.01^{abc}	0.00209 ± 0.00^{ab}	4.66^{E}-04 ± 0.00^{cdef}
Ekewan	0.0168 ± 0.00^{ab}	0.00579 ± 0.00^{ab}	0.199 ± 0.01^{b}	0.0721 ± 0.02^{b}	5.37^{E}-04 ± 0.00	3.29^{E}-05 ± 0.00^{a}	0.0168 ± 0.00^{a}	0.0144 ± 0.00^{bc}	0.0984 ± 0.01^{a}	0.0026 ± 0.00^{ab}	3.66^{E}-04 ± 0.00^{bcd}
Oluku	0.0627 ± 0.01^{c}	0.00524 ± 0.00^{ab}	0.251 ± 0.02^{bcd}	0.07 ± 0.01^{b}	7.69^{E}-04 ± 0.00^{ab}	4.60^{E}-05 ± 0.00^{abc}	0.0172 ± 0.00^{a}	0.0132 ± 0.00^{abc}	0.097 ± 0.00^{a}	0.00181 ± 0.00^{a}	6.44^{E}-04 ± 0.00^{f}
Upper	0.0214 ± 0.00^{ab}	0.0045 ± 0.00^{a}	0.311 ± 0.02^{d}	0.0741 ± 0.01^{b}	0.00137 ± 0.00^{ab}	6.70^{E}-05 ± 0.00^{cd}	0.0182 ± 0.00^{a}	0.0149 ± 0.00^{c}	0.105 ± 0.02^{ab}	0.0289 ± 0.00^{c}	5.22^{E}-04 ± 0.00^{def}
Dumez	0.0152 ± 0.00^{ab}	0.00432 ± 0.00^{a}	0.207 ± 0.02^{bc}	0.075 ± 0.01^{b}	0.00989 ± 0.00^{b}	3.30^{E}-05 ± 0.00^{a}	0.0165 ± 0.00^{a}	0.0127 ± 0.00^{abc}	0.104 ± 0.00^{ab}	0.02 ± 0.03^{a}	4.28^{E}-04 ± 0.00^{cde}
Uwasota	0.0172 ± 0.00^{ab}	0.00634 ± 0.00^{ab}	0.307 ± 0.03^{cd}	0.076 ± 0.01^{b}	9.59^{E}-04 ± 0.00^{ab}	4.50^{E}-05 ± 0.00^{abc}	0.0169 ± 0.00^{a}	0.0107 ± 0.00^{a}	0.1343 ± 0.01^{c}	0.00299 ± 0.00^{ab}	3.22^{E}-04 ± 0.00^{abc}
Eyan	0.0282 ± 0.00^{b}	0.0135 ± 0.00^{cd}	0.314 ± 0.11^{d}	0.0905 ± 0.01^{b}	5.66^{E}-04 ± 0.00^{ab}	7.30^{E}-05 ± 0.00^{d}	0.0198 ± 0.00^{a}	0.0148 ± 0.00^{c}	0.1643 ± 0.01^{d}	0.00534 ± 0.00^{b}	3.23^{E}-04 ± 0.00^{abc}
Federal	0.0095 ± 0.00^{a}	0.0189 ± 0.00^{de}	0.1024 ± 0.02^{a}	0.0362 ± 0.05^{a}	0.00158 ± 0.00^{b}	5.23^{E}-05 ± 0.00^{abcd}	0.0186 ± 0.00^{a}	0.0145 ± 0.00^{c}	0.183 ± 0.02^{d}	0.00374 ± 0.00^{ab}	2.25^{E}-04 ± 0.00^{ab}
Control	0.03 ± 0.01^{b}	0.02 ± 0.01^{e}	0.0733 ± 0.05^{a}	0.0337 ± 0.01^{a}	2.00^{E}-04 ± 0.00^{a}	1.30^{E}-04 ± 0.00^{e}	0.0122 ± 0.00^{a}	0.0144 ± 0.00^{bc}	0.127 ± 0.02^{bc}	0.0013 ± 0.00^{a}	1.67^{E}-04 ± 0.00^{a}

4. CONCLUSION

The atmospheric concentrations of trace elements, which are Ar, Ni, Fe, Sr, Ti, Cu, Zn, Zr, V, Ca and K were determined in nine different sites in both glass fibre filter and respirable foam using X-ray fluorescence. Metals were determined by X-Ray Fluorescence. The mean concentrations of the metal in the glass fibre filter (inhalable particle) and the respirable foam (PM2.5), in the locations were fell below the purview of the regulatory limit.

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REFERENCES

1. Anderson H.R., Bremner, S.A. Alkinson, R.W. Harrison R.M., Walters S.: Particulate matter and daily mortality and hospital admissions in the West midlands conurbation of the United Kingdom: Associations with fine and coarse particle, black smoke and sulphate occupational and Environmental Medicine 58, 504-510, 2001.
2. Artinano B., Salvador P., Alonso D. G., Querol X., Alastuey A.: Influence of traffic on the PM10 and PM2.5 urban aerosol fractions in Madrid (Spain) Science of the Total Environmental 334-335, 111-123, 2004.
3. Bessagnet, B., Hodzic, A., Blanchard, O. Lattuati, M., Le Bihan, O. Marfaing, H., Rouil.: Origin of particulate matter pollution episodes in wintertime over the Paris Basin. Atmospheric Environment 39, 6159-6174, 2005.
4. Bilos, C., Colombo, J.C., Skorupka, C.N., Rodrigues Presa, M. J.: Sources, distribution and variability if airborne trace metals in La Plata City area, Argentina. Environmental Pollution 111, 149–158, 2001.
5. Dick C.A.J., Brown D.M. Donaldson K., Stone W.: The role of free radicals in the toxic and inflammatory effects of four different ultra-fine particle types. Inhalation Toxicology 15, 39-52, 2003.
6. Ediagbonya, T. F; Tobin, A. E; Ukpebor, E. E.: The Level of Suspended Particulate Matter in Wood Industry (Sawmills) in Benin City, Nigeria. J.Environ. Chem. Ecotoxicol 5 (1):1-6, 2013a.
7. Ediagbonya, T. F; Tobin, A. E; Ukpebor, E. E; Okieimen, F. E.: An assessment of inhalation of particulate matter in urban and rural area of Nigeria. Journal of chemical, biological and physical sciences. 5(1):30-36, 2015.
8. Ediagbonya, T. F; Tobin, A. E; Ukpebor, E. E; Okieimen, F.E.: Prevalence of respiratory Symptoms among adults from exposure to particulate matter in rural area of Niger Delta region of Nigeria. Biological and environmental sciences journal for the tropics. 11(4):463-466, 2014b
9. Ediagbonya, T. F; Ukpebor, E. E; Okieimen, F. E., Momoh, O. L. Y.: Elemental Concentration of inhalable and Respirable Particulate matter in urban area during wet season.J.Appl.Sci.Environ.Manage.18(1):87-92, 2014a.
10. Ediagbonya, T. F; Ukpebor, E. E; Okieimen, F. E.: Baseline levels and distribution of airborne particulate matter in the urban town of sapele. Nigeria journal of applied science.32:67-76, 2014c.
11. Ediagbonya, T. F; Ukpebor, E. E; Okieimen, F.E.: Correlation of Meterological Parameters and Dust Particles Using Scatter Plot in Rural Community. Ife Journal of Science,15(3):445-453, 2013b.
12. EPA.: U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 261.24, 1980d.
13. Federman J. H, Sachter J. J.: Status asthmaticus in a paramedic following exposure to a roadside flare: A case report. J Emerg Med 15(1):87-89, 1997.
14. Fishbein L.: Sources, transport, and alterations of metal compounds: An overview: 1. Arsenic, beryllium, cadmium, chromium, and nickel. Environ Health Perspect 40:43-64, 1981.
15. Gehria R., Buchmann B.: Characterizing seasonal variations and spatial distribution of ambient PM10 and PM2.5 concentrations based on long-term Swiss monitoring data. Atmospheric Environmental 37, 2571-2580, 2003.
16. Gillett N. A, Muggenburg B. A, Boecker B. B.: Single inhalation exposure to 90SrCl2 in the beagle dog: Hematological effects. Radiat Res 110:267-288, 1987.
17. International technical information institute(ITII).: Toxic and Hazardous Industrial Chemical Safety Manuel, Tokyo, Japan, P.101, 1998.
18. Jones R. K, Boecker B. B, Pickrell J. A, et al.: Influence of radiation-dose pattern from inhaled betagamma-emitting radionuclides on canine peripheral lymphocytes. In: Radiation and the lymphatic system: Proceedings of the fourteenth annual Hanford biology symposium at Richland, Washington, September 30-October 2, 1974.Springfield, VA: Energy Research and Development Administration, 83-99, 1976.
19. Laden F., Neas L., Dockery D.W., Schwartz J.: Association of fine particulate matter from different sources with daily mortality in six US Cites Environmental Health perspectives 108, 941, 2000.
20. Lee, D. B. N; Robert, M; Bluchil, C. G; Odell, R. A.: Zirconium, Biomedical and Nephrological applications ASACV J,56(6):550-55, 2010.
21. Lees, R. E. M.: Changes in lung function after exposure to vanadium compounds in fuel oil ash. British journal of industrial medicine, 37:253–256, 1980.
22. Lenschow, P., Abraham H. J., Kutzner M., Lutz M., Preub J. D., Reichenbacher W.: Some Ideas about the Sources of PM10. Atmospheric Environment 35, 523-533, 2001.
23. Memmesheimer, M., Jakobs, H.J., Friese E., Muller, W.J. Ebel A., Feldmann, H.: Episodes of high concentrations of PM2.5 and PM2.5 over Europe in Winter 2002/2003. Meteorological conditions and chemical

composition as calculated with a complex operational short-term air quality model. Journal of Aerosol Science 35, 1251-1252, 2004.
24. Mogilevskaja OJa.: Titanium, alloys and compounds. In: Parmeggiani L, ed. Encyclopedia of Occupational Health and Safety 2:2179-2181, 1983.
25. Ragosta, M., Caggiano, R., Diemilio, M., Macchiato, M.: Source origin and parameters influencing levels of heavy metals in TSP, in an industrial background area of SouthernItaly. Atmospheric Environment 36, 3071–3087, 2002.
26. Report of the International Committee on Nickel Carcinogenesis in Man.Scandinavian journal of work, environment and health, 16: 1–82, 1990.
27. Ruojie. Z; Bin, H; Bing, L; Nan, Z; Lin, Z; Zhipeng, B.: Element composition and source apportionment of atmospheric aerosols over the China Sea Atmospheric Pollution Research 6 ;191-201, 2015.
28. Sabrina, Y. N; Jiang; Fenhuan Y, Ka, L. C. Z.: Water solubility of metals in course PM1 and PM2.5 in typical urban environment in Hong Kong. Atmospheric pollution research, 5:236-244, 2014.
29. Seaton, D., Godden W., MacNee, Donaldson K.: Particulate air pollution and acute health effects, lancet 345, 176-178, 1995.
30. Sweet, C.W., Vermette, S.J., Landsberg, S.: Sources of toxic trace elements in urban air in Illinois. Environmental Science and Technology 27, 2502–2510, 1993.
31. Tiitta, P., Raunemaa T., Tissari J., Yli-Tuomi T., Leskinen A., Kukkonen J. Harkonen J. Karppien A.: Measurements and modeling of PM2.5 concentrations near a major road in Kuopio. Finland Atmospheric Environment 36, 4057-5068, 2002.
32. Tsai Y.I., Cheng M.T.: Visibility and aerosol chemical compositions near the coastal area in central Taiwan. The science of the Total Environment 231, 37-51, 1999.
33. US EPA.: Environment Protection Agency Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Determination of Polycyclic Aromatic Hydrocarbons (PAHs) in Ambient Air Using Gas Chromatography/ Mass Spectrometry (GC/MS), Compendium Method TO-13A. 1999.

KVALITATIVNA ANALIZA FILTERA OD STAKLENIH VLAKANA I RESPIRABILNE PENE KORIŠĆENJEM X-ZRAKA FLUOROSENCIJE

Aerosoli u respirabilnoj peni su ispitivane pomoću SKC Air Check, visoko zapreminskog gravimetrijskog uzorkivača i. I.O.M uzorkivača. Elementi u tragovima u filteru od staklenih vlakana i respirabilne pene: K, Ca, Ti, Ar, Fe, Cu, Zn, Sr, Zr, V i Ni su analizirani korišćenjem X-zraka fluorosencije. Prosečne koncentracije elemenata u tragovima u česticama (PM10) u filteru od staklenih vlakana su: K,0.0824 ppm, Ca,0.051ppm, Ti,0.308 ppm, Ar,0.0716ppm, Fe,0.00129 ppm, Cu,0.00018 ppm, Zn,0.037 ppm, Sr,0.014 ppm, Zr,0.0123 ppm, V,0.00489 ppm, Ni,0.00049 ppm. Prosečne koncentracije elemenata u tragovima u respirabilnoj peni u česticama (PM2.5) su: K,0 .0354 ppm, Ca,0.0096 ppm, Ti, 0.235 ppm, Ar, 0.067 ppm, Fe, 0.00175 ppm, Cu, 0.0000756 ppm, Zn, 0.0226 ppm, Sr, 0.0133 ppm, Zr,0.127 ppm, V 0.0052 ppm, Ni,0.00040 ppm. Prosečne koncentracije elemenata u tragovima dobijenih ovom analizom su ispod propisanih graničnih vrednosti.

Ključne reči: *Aerosoli, Elementi u tragovima, grad Benin, Strugara, x-zraci fluorosencije*