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DETERMINATION OF SOME TRACE METALS IN COBWEBS AS INDOOR POLLUTANTS IN MODIBBO ADAMA UNIVERSITY OF TECHNOLOGY YOLA, ADAMAWA STATE, NIGERIA

Maitera, O.N.[1]
Ishaku, S.[2+]
Abubakar, A.B.[3]

[1]*Chemistry Department, Modibbo Adama University of Technology, Yola, Nigeria.*
Email: maiteriaon@mautech.edu.ng
[2]*Adamawa State Post Primary School Management Board, Yola, Nigeria.*
Email: ishakusunday946@gmail.com
[3]*Science Laboratory Department, Federal College of Horticulture, Dadinkowa, Nigeria.*
Email: abdulmb2000@yahoo.com

(+ Corresponding author)

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ABSTRACT

This study aimed at assessing the trace metals contents of cobwebs using atomic absorption spectroscopy. The cobwebs were collected from male's hostel; females hostel, chemistry laboratory, and lecture theatre areas in order to establish the level of suspended trace metals in the atmosphere. The cobwebs were digested with aqua regia before analysis using atomic absorption spectrophotometer (AAS). The highest concentration value of Fe, Mn, Zn, Cu, Pb, Co, Cd, Na, and Mg are 10.388±4.734, 4.228±3.267, 0.461±0.900, 0.639±0,529, 0.13±0.05, 0.115±0.099, 0.004±0.001, 0.600±0.400, and 0.015±0.035 mg/L respectively, from MH, FH, CL, and LT. It was found that, the concentration of trace metals in cobwebs decreases as the harmattan, burning of dumpsite, and school activities decrease. In general, the total concentration of all elements varied from 10.388 mg/L assessed at male hostel (MH) to 0.002 mg/L at lecture theatre (LT). The values recorded for all the element may be due to the use of cosmetic; dust, heating equipment (stoves, heater, fireplaces), paint, burning of refuses, vehicle emission, insecticide or pesticides usage, tobacco smoke around the study area. The fact that appreciable values of trace metals were recorded in the study area affirmed the presence of unsafe air in the institution. Therefore, there is a need not only to curb activities that increase these trace metals, but also to ensure perennial brooming and removing cobwebs dusts in the institution.

Contribution/Originality: The study affirmed the feasibility of cobwebs inhibiting trace metals, which accumulation of such metals is detrimental to human health on a longtime exposure. Therefore, incessant brooming of cobwebs in a building should be encouraged.

1. INTRODUCTION

In the last thirty years, huge attention has been given on reducing the outdoor pollution, but only recently has the international scientific community concerned about reducing the contamination of the air closed environments [1, 2]. Considering the time, a person spends in a closed environment (about 90%), then it is with utmost urgency to address the issue of indoor pollution Tran, et al. [3]; Ghanizadeh and Godini [4]. USEPA [5] put indoor pollution simply as "the presence of physical, chemical or biological contaminants in the air of confirmed environments, which are not naturally present in high quantities in the external air of the ecological systems. The main sources of indoor pollutants are: heating, air conditioning devices, cooking apparatuses, Furniture, Coatings (wall paint, varnish, floors etc.), maintenance and cleaning products (detergents, pesticides etc.), and use of space and activities done within it Tran, et al. [3]. One of the most remarkable indoor pollution is presence of heavy metals [6, 7].

The term heavy metals according to Al-Khashman [8], refer to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentration. Example of heavy metals include mercury (Hg), cadmium (Cd), arsenic (As), chromium (Cr), thallium (Ti), and lead (Pb). Heavy metals are natural component of the earth's crust. They cannot be degraded or destroyed [9]. According to Wuana and Okieimen [10], heavy metals can enter human body through food via ingestion, air via inhalation and dermal contact. As a trace element, some heavy metals (such as copper, selenium, and zinc) are essential to maintain the metabolism of the human body, however, at higher concentration it can lead to poisoning as Faiz, et al. [11], explained that heavy metals poisoning could result for instance, from drinking contaminated water (example lead pipes), high ambient air concentration near emission source, or intake via the food chain. Ingestion or inhalation of heavy metals has been associated with severe health implication such as cancerous growth, breaking down of nervous system, respiratory illness, slow growth development and cardiovascular deaths [12, 13].

Previous studies have identified dust as the major abode for heavy metals when it comes to indoor pollution. For instance, Xiao-Li, et al. [14] confirmed the presence of heavy metals indoor dusts of Muscat. However, a few reports [15-18] have indicated that cobweb has the potential of imbibing heavy metals in the indoor pollutions. According to Marples [19]; Goix, et al. [20], a spider web, or cobweb (from the absolute word copper, meaning "spider", sometimes with the connotation of being a dusty, abandoned web) is a device built by a spider out of proteinaceous spider silk extruded from its spinnerets. Spider webs which was reported to have been in existence for more than 140 million years. The main difference between the spider webs and the cobwebs is that spider webs are still in use webs, while cobwebs are webs that have been abandoned. Spider webs are found in many buildings in towns and villages of Nigeria. They are also a common sight in public school classes and hostels as a result of lackadaisical attitude on cleanliness, presumed harmless adventure of the cob webs or lack of knowledge on implication of spider webs. Unfortunately, most buildings plagued with spider webs are usually patronized by the majority of the public due to financial advantage [21].

Therefore, it is imperative to study the absorption of heavy metals in the cobwebs in order to prevent the grievous health implications that may arise as a result of constant exposure to heavy metals at indoor.

Figure 1. Typical example of cobweb [19].

Figure 1 illustrates a typical example of cobweb.

Figure 2. Typical Spider and cobweb [22].

Figure 2 illustrates a typical spider

2. MATERIAL AND METHODOLOGY

2.1. Materials

Cobwebs, Beaker, Heating mantle, HCl and HNO_3, H_2O_2, Atomic Absorption Spectrophotometer (AAS), de-ionized water, volumetric flasks, Air acetylene gas.

2.2. Methodology

2.2.1. Sample Collection

The cobwebs were collected according to method described by Rybak [15]; Hossain, et al. [23]. The indoor cobweb was collected from male and female hostel, Lecture Theatre and laboratories of Modibbo Adama University of Technology (MAUTECH) Yola, Adamawa State, Nigeria. To ensure uniform and comparable age of the cobwebs at each site, the cobwebs was identified and harvested after 7 days. A single empty room was cleaned and allowed to stay for two days. The new cobwebs were collected and serve as control.

2.2.2. Sample Preparation

The sample preparation was carried out according to the method described by Hossain, et al. [23]. 0.5 g of each sample of cobwebs were place into a beaker. 20cm^3 of aquilegia (mixture of concentrated HCl and HNO_3 acid ratio 3:1) were added and heat gently until a dark brownish gas liberated from the sample. Then it was allowed to cool and 10cm^3 of 30% H_2O_2 were added in small portion to avoid any possible flow leading to the loss of material from the beaker. It forms a colourless gas. The beakers wall was washed and transferred into 100cm^3 volumetric flasks and made to the mark with de-ionized water [14].

2.2.3. Sample Analysis

The trace metals concentrations were determined by Buck 210 model of Atomic Absorption Spectrophotometer (AAS). Atomic Absorption Spectrometer (AAS) was used for the determination of seven metals which are, Cd, Cu, Na, Fe, Mg, Zn, Cu, Mn and Pb. Cathode lamps for each element was used as a radiation source. Air acetylene gas was used for all the experiments. This method provides both sensitivity and selectivity since other elements in the sample will not generally absorb at the chosen wavelength and thus, will not interfere with the measurement [24].

2.2.4. Statistical Analysis

The result obtained were analysed statistically by using Statistical Package for Social Sciences (SPSS) version 22, while the analysis of variation (ANOVA) was used to analysed the level of significance of variation between samples.

3. STUDY AREA

The study area for this research is Modibbo Adama University of Technology (MAUTECH), Yola, Adamawa State, Nigeria. The main campus is located along Yola-Girei-Mubi road, about 13km from Jimeta, town. The campus is a home to over 5,000 individual including lecturers' quarters, different Male and Female hostels.

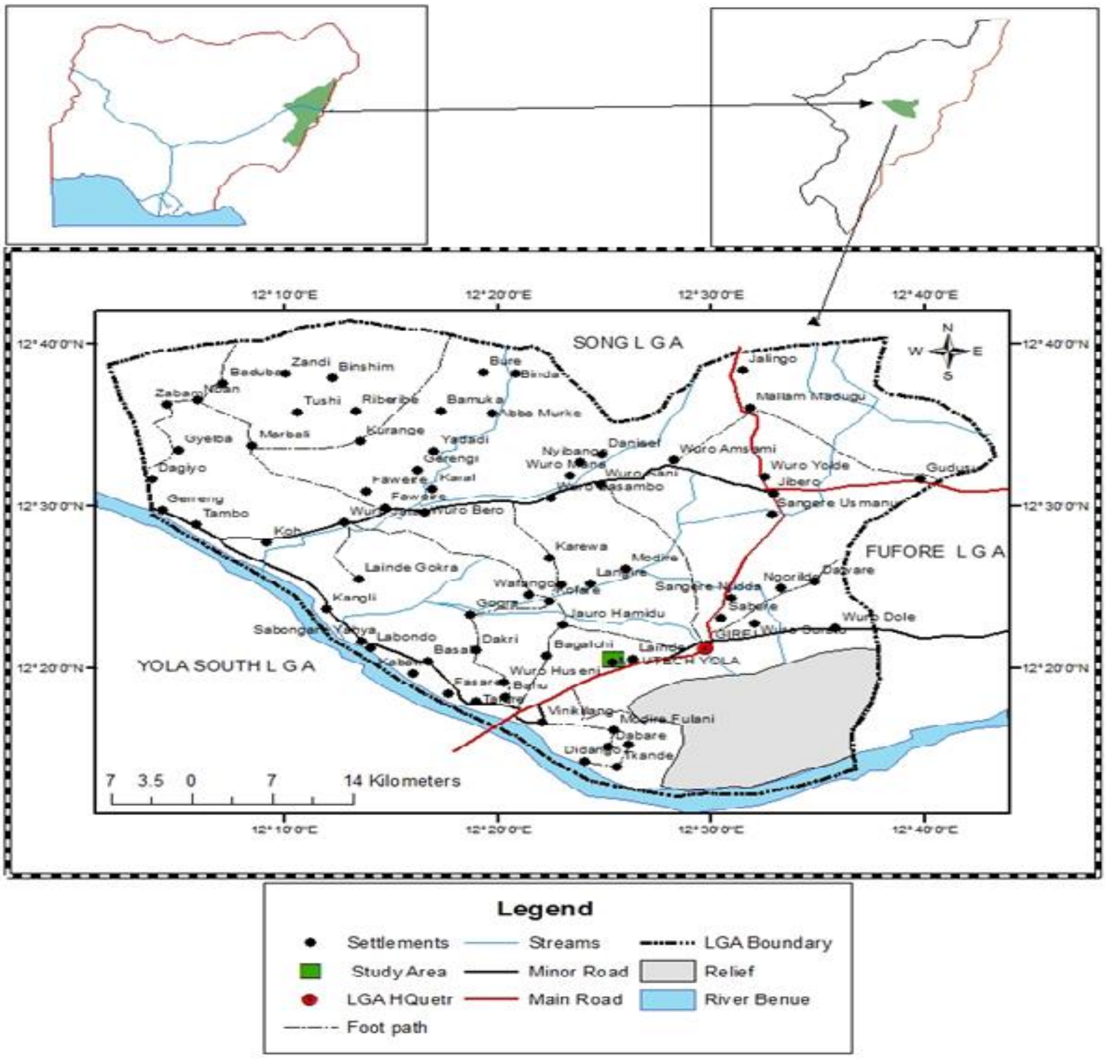

Figure 3. Map of Girei showing MAUTECH.

Source: Geography department, MAUTECH.

Figure 3 illustrates the map of Nigeria where green area is used to designate the map of Adamawa State. Also, in the map of Adamawa state, green map was used to designate Girei Local Government, which is the local government where Modibbo Adama University of Technology is situated.

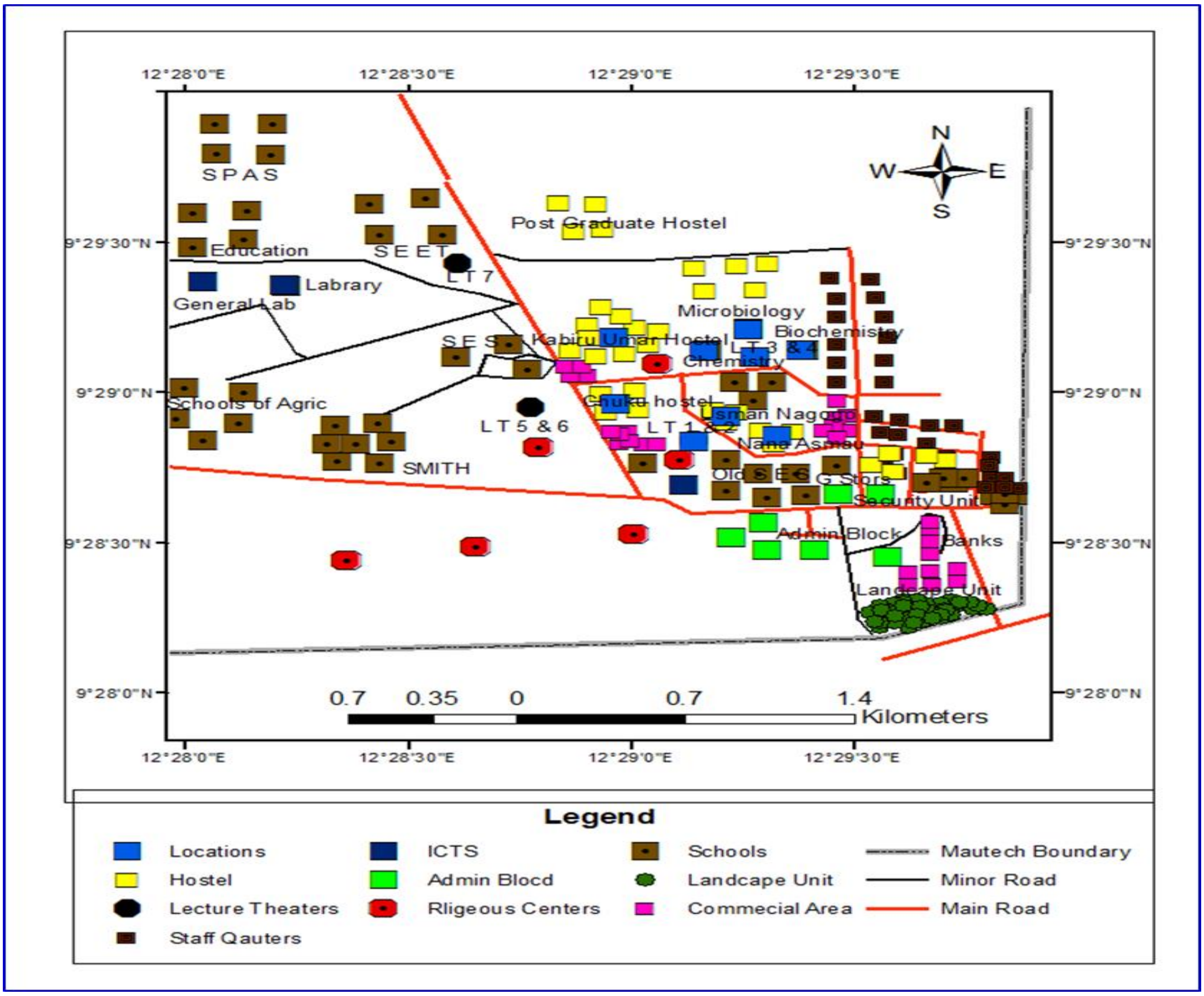

Figure 4. Map of the Study Area showing different departments and units present in the university.

Figure 4 illustrates the map of MAUTECH showing places and departments present in the university.

4. RESULT AND DISCUSSION

4.1. Results

Table 1 showed detailed results obtained from different locations. The highest mean Iron (Fe) concentration value of 10.388±4.734, and 10.043±3.967 mg/L was recorded from MH and CL respectively. The mean Fe value of 9.688±5.339 and 7.237±3.757 mg/L was recorded from FH and LT Similarly, the highest mean manganese (Mn) concentration values of 4.288±3.267, 4.042±3.203, and 2.780±1.879 and 2.298±1.734 mg/L was recorded for MH, FH, CL and LT respectively. The mean values of Zinc (Zn) concentration from MH, FH, CL, and LT are: 0.300±0.0504, 0.97±0.0179, 0.365±0.0949, and 0.461±0.0901 mg/L, respectively. The mean values of lead (Pb) concentration from MH, FH, CL, and LT area respectively are: 0.042±0.009, 0.036±0.001, 0.031±0.0012 and 0.048±0.003 mg/L. The mean values of Copper (Cu) concentration recorded from MH, FH, CL, and LT are 0.639±0.529, 0.468±0.0519, 0,592±0.310, and 0.4700±0.244 mg/L respectively. The mean values of Cobalt (Co) concentration from MH, FH, CL, and LT location are: 0.68±0.010, 0.115±0.099, 0.71±0.099 and 0.810±0.096mg/L. The highest mean cadmium (Cd) concentration value of 0.003±0.001 mg/L was recorded from MH, CL and LT, and 0.004±0.001 mg/L from FH. The highest mean sodium (Na) concentration value of 0.534±0.358, 0.600±0.401, 0.468±0.377, and 0.390±0.355 mg/L was recorded from MH, FH, CL, and LT respectively. The highest mean

Magnesium (Mg) concentration value of 0.003±0.001 mg/L was recorded from MH, and FH, 0.005±0.007 mg/L from CL and 0.15±0.035 mg/L from LT. The mean concentration value of 0.003±0.001 mg/L was recorded in Lead (Pb) from LT, cadmium (Cd), from MH, LT, and CL. According to the values, the most accumulated element in cobwebs was Fe, then in descending order Mn>Zn>Cu>Cr>Co>Mg>Pb> and Cd. The highest differences between male hostel, female hostel, Chemistry laboratory and Lecture Theatre were observed for Fe, Mn, Zn, Cu and Na concentration at female hostel, male hostel, Chemistry laboratory, and lecture Theatre respectively. Cobwebs showed lower element concentrations (Co, Mg, Pb and Cd) at male hostel, Lecture Theatre, female hostel and laboratory.

Table 1. Mean concentration value of trace metals obtained in the various sample location.

Sample Elements	Fe	Mn	Zn	Cu	Pb	Co	Cd	Na	Mg
MH1	0.025	0.045	0.002	0.024	0.040	0.021	0.001	0.150	0.011
MH2	7.300	1.350	0.019	0.400	0.080	0.045	0.004	0.900	0.014
MH3	9.950	1.590	0.030	0.575	0.070	0.063	0.007	1.050	0.023
MH4	4.450	0.825	0.024	0.220	0.020	0.062	0.005	1.200	0.004
MH5	8.225	1.290	0.270	0.044	0.060	0.021	0.006	1.200	0.003
MH6	7.525	1.140	0.052	0.024	0.040	0.021	0.007	0.150	0.004
MH7	4.825	1.305	0.024	0.242	0.040	0.042	0.003	0.150	0.003
MH8	0.224	0.495	0.018	0.176	0.030	0.021	0.004	0.150	0.103
FH1	14.725	6.00	0.032	1.518	0.040	0.042	0.006	0.900	0.002
FH2	16.150	6.900	0.038	1.650	0.040	0.165	0.006	1,050	0,002
FH3	12.006	0.770	0.044	0.907	0.010	0.021	0.005	1.050	0.001
FH4	6.900	4.275	0.022	0.132	0.050	0.021	0.002	0.090	0.002
FH5	13.050	4.470	0.041	0.553	0.030	0.021	0.002	0.209	0.001
FH6	15.300	7.180	0.041	0.396	0.060	0.315	0.004	1.200	0.002
FH7	12.175	5.430	0.041	0.330	0.030	0.314	0.002	0.170	0.002
FH8	9.600	3.225	0.041	0.331	0.030	0.315	0.002	0.300	0.001
CL1	9.100	2.070	0.550	0.286	0.040	0.315	0.004	0.310	0.001
CL2	14.675	6.000	0.024	0.660	0.010	0.163	0.003	0.301	0.001
CL3	15.475	4.530	0.027	0.198	0.020	0.021	0.003	0.150	0.002
CL4	11.250	4.125	0.019	0.506	0.020	0.063	0.002	0.450	0.001
CL5	12.425	4.300	0.016	0.660	0.070	0.042	0.003	0.455	0.002
CL6	3.150	0.900	0.014	0.286	0.010	0.042	0.003	0.300	0.002
CL7	3.550	0.720	0.016	0.418	0.080	0.021	0.001	0.450	0.002
CL8	11.650	0.225	2.513	0.880	0.010	0.063	0.003	0.330	0.004
LT1	13.700	5.100	0.030	1.166	0.060	0.042	0.004	0,600	0.001
LT2	10.600	7.905	0.049	0.044	0.020	0.125	0.004	0.600	0.001
LT3	10.815	3.840	0.027	0.714	0.080	0.042	0.003	0.410	0.002
LT4	6.525	3.840	0.022	0.462	0.030	0.042	0.002	0.450	0.002
LT5	11.850	10.550	1.455	0.858	0.010	0.042	0.001	0.451	0.002
LT6	2.800	0.960	0.540	0.285	0.040	0.042	0.001	0.300	0.001
LT7	11.550	4.060	2.713	1.034	0.030	0.043	0.002	0.311	0.001
LT8	7.300	1.376	1.029	0.506	0.030	0.063	0.002	0.150	0.002

Note: MH- Male Hostel, FH- Female Hostel, CL- Chemistry Laboratory, LT- Lecture Theatre.

The statistical analysis of results of metal samples analysed from cobwebs collected from Male hostels (MH), Female hostels (FH), Chemistry laboratory (CL), and Lecture Theatre (LT). There was a significant difference in concentration of the entire element from MH, FH, CL, LT areas.

The highest concentration of Fe, Mn, Zn, Cu, Pb, Co, Cd, Na, and Mg are 10.388±4.734, 4.228±3.267, 0.461±0.090, 0.639±0.0529, 0.13±0.05, 0.115±0.099, 0.004±0.001, 0.600±0.400, and 0.015±0.035 mg/L respectively. This fact was further corroborated by the results of statistical analysis which showed that the concentrations of Fe, Mn, Zn, Cu, and Cr was significantly higher in cobweb samples collected from MH, FH, CL, LT areas with the mean value concentration of 10.388 ±4.734, 10.550±00300, 2.713±002000, 1.650±005000, and 1.200±005000 mg/L while there was difference in the mean values of Fe recorded from MH, CL, and LT locations. Similarly, Co, Mg, Pb, and

Cd concentration was significantly lower in MH, FH, CL, and LT areas with the mean value of 0.315±0.050, 0.103±0.030, 0.80±0.0100, 0.70±0.020 mg/L respectively.

4.2. Discussion

4.2.1. Iron

The maximum value of iron (Fe) was obtained at male hostels (MH) 10.387±4.734 mg/ this might be as result of much use of cooking apparatus and burning of dump site in the location, which in variance with Rybak and Olejniczak [16] who reported the maximum value of iron are 9.654±0.867 at high traffic site 5 then at post-industrial site 4 (7.774±0.20). Iron is found in many of igneous rocks, and in clay minerals. Because of the physical and chemical properties, it has wider application in construction metal industries [25-27].

4.2.2. Manganese

The highest mean value concentration manganese (Mn) was measured at male hostel (MH) with the mean value of (4.228±3.267 mg/L. this is at variance with the work of Rybak and Olejniczak [16], reported the highest value of Mn (660±10.5). The presence of Mn, derives from the petrol combustion [2]. Vehicle traffic is responsible for the emission of some metals, originates from coal, oil, and gas combustion. Manganese is added instead of Pb^{2+} to increase the octane number of fuel [28, 29].

4.2.3. Zinc

The maximum mean value of zinc (Zn) was measured at 0.461±0.090 from lecture theatre (LT) which in variance with the work of Rybak and Olejniczak [16] which reported the highest value of Zn (3268±8.9) at site 4 then (2833±176) at site 5, this might be due to vehicle emission.

Zinc is always connected with anthropogenic emission sources such as traffic emissions [30]. It is transmitted (altogether with Ca) as a result of engine oil usage by high frequency of heavy vehicle traffic may influence the high values of Zn derived, probably from vehicle emissions [27].

4.2.4. Copper

The highest mean concentration value of copper (Cu) was also at male hostel (MH) (0.639±0.529 mg/L) this maybe as a result of commercial activities in the area, [30, 31] revealed that brake wear from road traffic vehicles is a major source of atmospheric (particulate) copper concentrations in Europe.

4.2.5. Lead

The highest lead (Pb) mean value concentration was reached 0.034±0.001 mg/L) at female hostel (FH) and laboratory (CL). This might be due to usage of cosmetics, emission from cooking apparatus and laboratory activities. This is at variance with the work of Rybak and Olejniczak [16] who reported the maximum value of 525.6±9.59 at road site. The use of unleaded gasoline has decreased significantly the release of tetraethyl lead into the air but the overall lead presence in the air is still high [31, 32].

4.2.6. Sodium

The highest mean Na concentration 0.600±4.00mg/L at female hostel (FH) this might be due to high patronage of female materials that may result in leaching of sodium [33].

4.2.7. Other Elements

The maximum mean concentration value of Mg, and Co, 0.14±0.035, and 0.114±0.099 mg/L from lecture theatre (LT), female hostel (FH) respectively this is at variance with the work of Rybak and Olejniczak [16] who reported that the highest value of Mg, 11.39 ±2.61 at road site, Co 3.7±1.1 from road site, this is because of the high emission from the location. Such elements like Mg, and Co could originate mainly from dispersed road windblown dust Rybak and Olejniczak [16], but some of them (Co) could be also emitted by road traffic [34, 35].

In general, the total concentration of all elements varied from 10.388 mg/L assessed at male hostel (MH) to 0.002 mg/L at lecture theatre (LT) and male hostel (MH). Thus, we could assume the airborne particles comprise about, from 10 mg (1%) to 200 mg (20%) of the total weight of web depending on the site (we took into consideration the total concentration of all elements and added similar value for other pollutants presented in dust such as SiO_2 not studied in this paper.

The presence of trace metals in the cobwebs maybe due to activities such as the use of cosmetic, dust, heating equipment (stoves, heater, fireplaces) etc. as [36] reported that cobwebs are one of the terrestrial invertebrates that accumulate the high concentrations of many trace metals.

5. CONCLUSION

The study examined the concentration of trace metals in suspended particles in cobwebs from males' hostels, females' hostels, Chemistry laboratory, and lecture theatres areas of Modibbo Adama University of Technology, Yola. The study affirmed the presence of trace metals in cobwebs in all the studied locations. The most accumulated element in cobwebs was Fe, then in descending order Mn>Zn>Cu>Cr>Co>Mg>Pb> and Cd. The highest differences between male hostel, female hostel, Chemistry laboratory and Lecture Theatre were observed for Fe, Mn, Zn, Cu and Na concentration at female hostel, male hostel, Chemistry laboratory, and lecture Theatre respectively. Cobwebs showed lower element concentrations (Co, Mg, Pb and Cd) at male hostel, Lecture Theatre, female hostel and Chemistry laboratory. The concentration of trace metals in cobwebs from the study areas are attributed to vehicular movement, burning of dump site, cookware's, cosmetics, insecticide, and paint. On a long exposure to this contaminated cobweb, it may be harmful for students and staff of the institution, thereby, appropriate measure needs to be taken urgently, in order to forestall possible breakdown of health of both staff and students.

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