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A case study of Amreyah cement factory and human health; problem and solution

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Abstract: The present study examined the potential capacity of cement dust pollution on human health at Gharbanyyate district. The objective was prolonged to endorse specific herbal formulas (suggested solution) as supplements for decreasing the noxious consequences of the frequent heavy metals on human. Soil samples were collected from topsoil (0-30 cm) at various distance points around the cement factory and analyzed for some specific heavy metals. Control samples were taken opposite the wind direction 3200 m from the factory. This paper recognized certain divergent means by which these metals can be presented in the human body. An herbal assemblage (ABCOSTU; Arctium lappa, Berberis vulgaris, Coriandrum sativum, Olea europaea, Silybum marianum, Tribulus terrestris and Urtica dioica) was prepared in according to the kinds and categories of the different heavy metals concentrations. It was proved that soil pH fluctuated between 6.18 to 8.43 versus the controlled pH with value 6.11. The EC level as well as Cr and Cd significantly ($p \leq 0.05$) decreased with increasing distances from the factory. Assemblage of six continues months was applied and demonstrated a significant enhancement ($p \leq 0.05$) in the medical examined cases documented in the study areas. The study suggests a potential association between exposure to cement dust and an increased risk of some diseases including respiratory diseases as well stomach and rectal cancers. Instituting healthcare specialized sequences in these polluted areas are essential as an important portion in the plan of the sustainable development plan in order to rescue the affected rural communities.

Keywords: Industrial pollution, Cement factory, Heavy metals, Herbal formula, Detoxification.

Introduction

Unfortunately, cement factories may be situated in urban areas that have high population density; nevertheless, these factories emit and produce several emissions with detrimental elements, vaporous contaminants (i.e., nitrogen oxides, sulfur oxides, carbon oxides) and heavy metals (**Lei *et al.*, 2011; Leone *et al.*, 2016; Chen, 2020; Wu, 2021 and Akpambang *et al.*, 2022**). So, the existence of these factories has been interrelated with transformed air

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(**Leone *et al*., 2016**). **Rafetti *et al*. (2019) and Garcia-Perez et al. (2017)** showed that there was an amplified danger of antagonistic health consequences in the exposed adults and children.

Zhou *et al*. (2020) estimated that in the developing countries, people in the suburban areas are very sensitive for these air pollutants. In Egypt, cement dust industry is considered as the chief stake industry of the highly labor-intensive construction materials that contributes with high percentage of the Egyptian economy nearly recorded 6-8.8% per year. Cement is used extensively in the construction industry; however, it contains hazardous chemicals and heavy metals **(Bakhtyar *et al*., 2017).** Also, **Gupta *et al*. (2013)** demonstrated that according to the list of the central pollution control board; the cement industry is classified as the most polluting industries**.** **Chidambaram *et al*. (2009)** verified that there are diverse heavy metals such as Cd, Cr, Co, Pb, Hg and Ni are predominant in the cement dust; which are injurious to the biotic environment, soil as well as with diverse influence on the natural vegetation, human, animal health and ecosystems. Several studies have dealt with the impact of cement dust on the vegetation around **(Migahid & El-Darier, 1995; Fakhry, & Migahid, 2011; Abdel- Rahman & Ibrahim, 2012, Shah *et al*., 2020 and El-Moaty *et al*., 2022).**

Practice of heavy metals in industry and technology is abundant and has an extensive spreading that threated the nature due to their harmful effects on human health and environment. DNA and other cellular components in the human cells interact with such metallic ions; which lead to DNA damage, apoptosis, carcinogenesis and other cellular changes. These events occurred during direct contact with these heavy metals through several means like inhalation, ingestion and dermal contact that lead to plentiful health problems such as cancer, diabetes, cardiovascular diseases as well as neurological, neurobehavioral and blood abnormalities. For eradication of these metals from body, there are several methods are detected, the most public one is the administration of chemical chelators. Nowadays, there is more attention for using the substances that have natural sources; especially the herbal remedies in therapeutic purposes. WHO assessed that about 4 billion people rely on herbal remedies for their primary healthcare (**Bandaranayake, 2006**). Nevertheless, the presence of these metals has a destructive influence on the efficiency, safety and quality of these herbal products (**Murch *et al*., 2003**).

Medicinal herbs have no or rare side effects, so the researchers use them for detoxification and handling the poisonous resulting from these heavy metals; by decreasing the bioavailability of these toxins and increasing gastrointestinal movements which lead to more rapidly excretion of these toxins **(Al-Snafi, 2016).** This technique can be considered as supplementary to diminish the poisoning effects of heavy metals if ingestion is the rout of exposure (**De Smet *et al*., 1992). Klein and Kiat (2015)** approved that there was a significantly reduction in the absorption of heavy metals by the regular consumption of herbal products; so it can be used as an alternative-medicine to relief the human body from the undesired toxins and prevent its accumulation to protect the individual health from its adverse short-term or long-term effects.

Reasonably, the study is considered important from a scientific, health, and economic point of view, as it is taking place in areas that suffer from cement factory pollutants, which cannot be shut down as a pillar of the national economy, and also the population cannot be left to suffer from diseases caused by this pollution. This gives the current topic scientific impetus as it differs from other research in this field, as well as the experience of using alternative medicine and its curative power to solve some national problems.

Materials and methods

1. Study Site

The study site was selected at Gharbanyyate district (55 km west of Alexandria city) represented by cement factory **(Figure 1)**. It lies between latitude 30.9150° N, and longitude 29.5456° E. Vegetation in the area consists mainly of halophytic species with some annuals during rainy seasons. Fig and olive orchards in addition to some field crop are present. The inhabitants are mainly small farmers, Bedouins and traders living in scattered houses and villages located only a few kilometers or less from the factory (**Migahid & El-Darier, 1995**).

Figure 1. Map of the north western coast of Egypt indicates the location of the study site.

2. Sampling and Analysis of Soil

2.1 Sampling

Collection of samples was carried out in triplicate from six sites at diverse distances from the factory

Table1. Suggested list of medicinal plants expected to chelate heavy metals in cement dust

Medicinal plant	Botanic Family	English name	Organ used	Sharing %	Reference
***Arctium lappa* L.**	Asteraceae	Burdock	Roots	18	(**Wang *et al*., 2019**)
***Berberis vulgaris* L.**	Berberidaceae	Barberry	Roots	12	(**Alimardan *et al*., 2016**)
***Coriandrum sativum* L.**	Apiaceae	Coriander	Leaves	10	(**Sahib *et al*., 2013**)
***Olea europaea* L.**	Oleaceae	Olive	Leaves	17	(**Gunes & Arslan, 2018**)
***Silybum marianum* L.**	Asteraceae	Milk thistle	Fruits	13	(**Sean *et al*., 2014**)
***Tribulus terrestris* L.**	Zygophyllaceae	Puncture vine	Shoots	15	(**Hashim *et al*., 2014**)
***Urtica urens* L.**	Urticaceae	Stinging nettle	Shoots	15	(**Telo *et al*., 2017**)

(site **I**: inside the factory, site **II**: 200, site **III**: 400, site **IV**: 800, site **V**: 1600 and site **VI**: 3200m) taking in consideration the dominant direction of wind where the cement dust is blown. Collection of control samples were carried out in the opposite direction of wind 3200 m from the factory. All soil samples were collected using a stainless steel soil auger. Then, samples were placed in polyethylene bags and transported to the laboratory **(Wufem *et al*., 2013).** Coarse materials and debris were sorted out of the samples then air-dried for 72 hours. After which they were ground with a mortar and pestle, passed through a 2 mm sieve and stored for subsequent analysis.

2.2 Analysis

The soil analyses were accomplished according to **Ideriah *et al*. (2007)** as following:

1. Weighing 1g of each soil sample in 100 ml Kjeldahl digestion flask.
2. Adding 20 ml of mix (concentrated HNO_3 with HCl 1:3).
3. Heating in a fume cupboard until dry and clear solution.
4. Cooling and filtration using Whatman filter paper into a 50 ml standard flask and made up to mark with distilled water.
5. Analyzing of the digests for Cd, Co, Cr, Hg, Pb, and Ni using Atomic Absorption Spectrophotometer.
6. Determining the pH of soil using pH meter (with 1:4 soil/water suspensions).
7. Determining soil texture and conductivity by using the hydrometer method and the conductivity meter, respectively.
8. Determining cation exchange capacity (CEC).

3. Air Quality Assessment

1. Collection of the total suspended particulates **(TSPs)** in air of the study sites and control was carried out by usage of high volume sampling technique (FandJ specialty Inc. DH-504EV.2, USA using FandJ filter discs, FP-4.0M) that are specially designed to afford incessant air sampling **(Bada *et al*., 2013; Algandaby *et al*., 2022).**
2. Collection of 30 samples during summer were completed; by a flow rate (60 L/min) on Whatman GF/A glass microfiber filter (47mm in diameter) and 99% collection efficiency for particles of 0.3 microns placed at 1.7 m above the ground (**Al-Jallad *et al*., 2017).**
3. Extraction of six trace metals; Cd, Co, Cr, Hg, Pb and Ni from soil were carried out using digestion with HNO_3 and it is facilitated through heating and addition of mix [HNO_3 and HCl (1:1)] (Merck, Germany)
4. The extract was diluted to analyze the concentrations of trace metals using flame atomic absorption spectrophotometer (Varian AA 240, USA) with an air/acetylene burner. Preparation of blank as well as standard solutions, maintained by Perkin Elmer, was carried out for checking for the presence of examined metals (**Jalees & Asim, 2016**).

TSP (Conc.) = Δw/ (Δf X Δt) (µg/m^3)

Where: Δw: is the weight of filter paper after sampling – weight before sampling

Δf: is the average of flow rate (initial flow rate + final flow rate) / 2

Δt: is the sampling time (finial time – initial time).

4. Health Situation and Care

Evaluation of health condition for the inhabitants was achieved by applying well-designed open-ended questionnaire that comprised several parameters about the different identified diseases in these areas. These parameters included the following:

a) Number of family members with chronic diseases in the preceding year.
b) Days spent in sickness.
c) Number of appointments to hospital.
d) Amount of money paid for treatments.

Then, the attained data was compared and verified by population archives in health care centers.

4.1 Herbal formula

According to **Algandaby *et al*. (2022)** assemblage of modified herbal formula was assessed. It is thought that its performance is chelating complexes to relief the poisonousness of heavy metals dominant in the cement dust (**Table 1)**. Administration of this formula was accomplished according to the selected samples of inhabitants as; 10 g twice daily was administrated (each 5 g every 12 hours half an hour before a meal as herbal tea) for each selected individual; for nonstop six months. Successively, tabulating the category and harshness of the identified ailments was done.

5. Statistical Analysis

All determinations had three replicas and several statistical analyses were performed as; One-Way Analysis of Variance (ANOVA) as well as mean by Duncan's multiple-range test (DMRT) by utilizing SPSS **(Granato *et al.*, 2014).**

Results and discussion

Heavy Metal Concentrations

Jaishankar *et al.* (2014) and Kabir *et al.* (2021) illustrated that environment has plentiful of chemicals that are found everywhere; water, air, food as well as human. All cancer types are toxin-related that also lead to diverse illness as neurological diseases, autoimmunity, reduced immune function, allergies and chemical sensitivity, chronic fatigue syndrome and fibromyalgia. These toxins may be several unfavorable components such as heavy metals especially if they are founded in high concentrations. **Table (2 &3)** showed concentration mean of the examined heavy metals (HM) in the inspected sites; and the results revealed that all metals in the polluted sites possessed high concentrations than that in control site.

Cd and Cr were determined at the locations near the factory with high concentrations, it attained (42.24, 88.08 %) in site I as compared to control site, while those of Pd, Ni and Hg were obtained at low concentration, Co is not detected. Site I exhibited the highest concentration of all heavy metals. The Cr is a pervasive environmental contaminant that is of great importance because of its toxicity. And it attained the highest values (1.93 mg/ kg) the data recorded that all parameters decreased gradually as the distance increase from the factory.

Cadmium (Cd) is a trace metal with toxic attitudes possessed a health risk for livings; occurred in natural form in the environment but it may be act as a pollutant resulting from agricultural and industrial sources; so, appropriate treatments are urgently needed (**Abdel-Daim *et al.*, 2018**). Such treatments are preferred to follow three steps; evading of additional toxic contact, supplementing with nutrients to increase

Furthermore, **Bungau *et al.* (2021); Kaur *et al.* (2018) and Balafrej *et al.* (2020)** recommended the cultivation of some plant species in the polluting sites which have the phytoremediation ability to clean the environment from these heavy metals by accumulating them in their cells with eight times more than the other plant species as they are considered as hyper-accumulators. These species are *Brassica juncea*, *Helianthus annuus*, *Plantago lanceolata*, *Lotus corniculatus*، *Thymus serpyllum*, *Rumex acetosa*, *Solanum lycopersicum*, *Cucurbita melo*, *Cucurbita pepo* and *Cynara scolymus*.

Health Situation and Care

Figure 2 showed the mean values of the family health situation in the polluted and control sites. It was obvious that all parameters in the polluted sites are significantly possessed high values than ones in control site with ($p \leq 0.05$); which is also enhanced by administration of the herbal formula used for six months **(Table 4).** The enhancement percentage was fluctuated from ٢٧ to ٣٧% amongst the studied parameters.

In the industrialized countries, the extended contact with any toxic metals is a crucial problematic (**Sinicropi *et al.*, 2010**) estimated that. As, these metals obstruct several physiological procedures in human body such as the central nervous system (CNS), hematopoietic, hepatic and renal functions. To perform an accurate evaluation of the toxicity of any of these metals; it is very important to take in consideration diverse limitations like; its chemical form (elemental, organic or inorganic), its binding ability, its attendance with the specific proteins that will select this metal to bind with. It is crucial to carry our medical treatments of this severe and long-lasting metal toxicity through using chelating agents; which have the capability to interfere with metal ions forming chelates.

The epidemiological data suggested that exposure to cadmium may be a cause for various kinds of cancer such as breast, lung, prostate, nasopharynx, pancreas and kidney cancers; especially for individuals who consumed plants and animals that have long half-life time ranged from 25-30 years because it accumulate Cd in high amounts. Also, environmental cadmium is considered as a risk issue for osteoporosis. There are some tissues in the body are highly sensitive to the toxicity of Cd; such as liver and kidney due to its capability to manufacture metallothioneins (MT) that are Cd-inducible proteins responsible for the cell protection by binding to the toxic ions. There are several mechanisms accountable for liver and kidney diseases like the oxidative stresses caused by xenobiotic. Moreover, mitochondria that has a crucial role in the formation of ROS (reactive oxygen species), its dysfunctional is extremely reasonable assumed due to cadmium toxicity. Other studies showed that cadmium encourages numerous epigenetic fluctuations in mammalian cells both *in vivo* and *in vitro* that lead to pathogenic hazards and progress several types of cancer (**Genchi *et al.*, 2020**).

Table 2. Mean physical and chemical properties of soil (mg/kg). (ND: Not detected)

Parameter	Sites and distance (m) away from the cement factory						
	I (0)	II (200)	III (400)	IV (800)	V (1600)	VI (3200)	Control
Heavy metals							
Cd	12.6	16.5	9.5	13.5	15.0	4.4	0.23
Co	ND	ND	ND	ND	ND	ND	ND
Cr	7.23	5.15	3.55	2.11	0.75	0.50	0.23
Hg	0.15	0.17	0.12	0.19	0.16	0.09	0.05
Pb	2.76	17.43	34.12	12.77	4.0	10.4	0.86
Ni	2.9	14.9	10.13	28.15	8.92	5.52	0.32
Physical Characteristics							
Organic matter	6.37	6.00	5.93	5.91	5.21	6.32	7.14
Water holding capacity (%)	65.9	62.1	69.3	63.4	66.15	67.13	70.46
Ph	8.93	7.44	7.1	6.8	6.5	6.25	6.12
Texture (%) Sand Silt Clay	 89.1 9.2 1.7	 85.28 6.00 8.72	 87.5 7.4 5.1	 90.76 4.7 4.54	 90.00 5.34 4.66	 86.66 8.54 4.80	 89.14 6.76 4.1
EC (ds/m)	7.00	6.78	6.51	5.3	4.0	2.1	1.2
Calcium carbonate (%)	22	22	24	23	26	23	19

Table 3. Average heavy metal (HM) concentrations of TSP (mg/kg) at the studied sites during summer season. Mean of three replications in duplicates ± Standard deviation. (ND: Not detected)

Parameter	Sites and distance (m) away from the cement factory						
	I (0)	II (200)	III (400)	IV (800)	V (1600)	VI (3200)	Control
Cd	1.61 ± 0.33	1.59 ± 0.22	1.55 ± 0.18	1.45 ± 0.12	1.43 ± 0.18	1.24 ± 0.14	0.93 ± 0.37
Co	ND	ND	ND	ND	ND	ND	ND
Cr	1.93 ± 0.96	1.15 ± 0.09	1.55 ± 0.16	.81 ± 0.08	0.75 ± 0.11	0.5 ± 0.04	0.23 ± 0.01
Hg	0.005± 0.00	0.004± 0.00	0.004± 0.00	0.005± 0.00	0.003 ± 0.00	0.002 ± 0.00	1.05 ± 0.02
Pb	0.55 ± 0.01	0.43 ± 0.01	0.12 ± 0.02	0.17 ± 0.00	0.04 ± 0.00	0.02 ± 0.00	0.02 ± 0.00
Ni	0.26 ± 0.02	0.22 ± 0.02	0.16 ± 0.03	0.11 ± 0.01	0.06 ± 0.02	0.05 ± 0.01	0.01 ± 0.00

Health Situation and Care

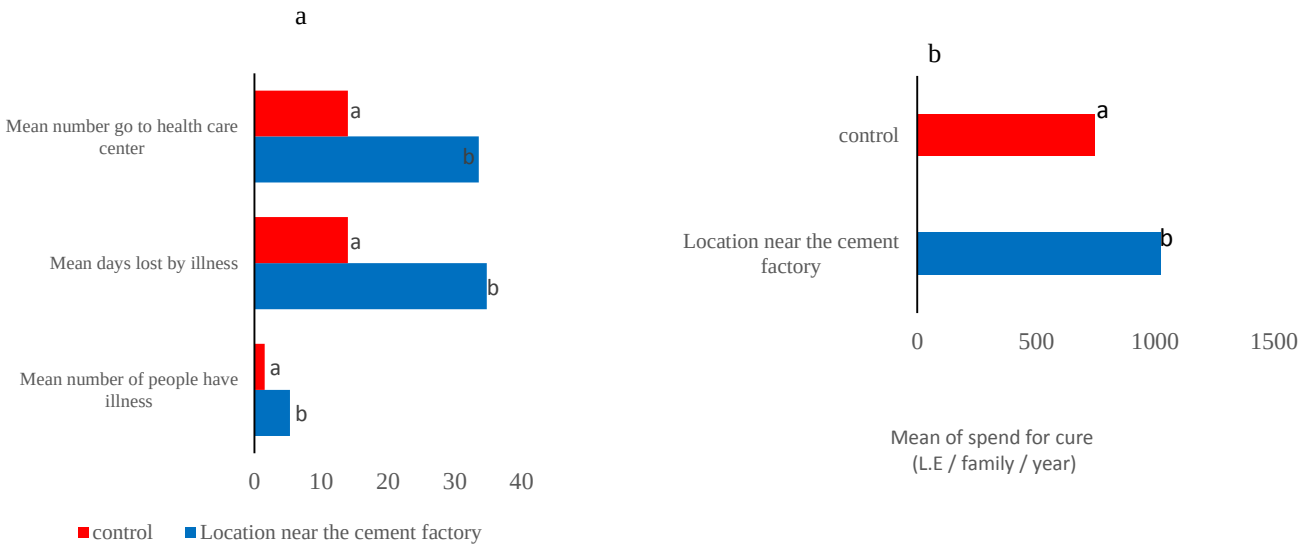

Figure 2. (a) Mean values of family health situation and (b) mean of spend for cure in the location near the cement factory as well in the control sites. Means with identical letters within graphs do not differ significantly at the 0.05% level of probability based on Duncan's multiple range test.

Table 4. Mean values of family health situation in the location near the cement factory as well in the control sites after administration of the herbal formula for six continual months and their percentages of improvement. Means with identical letters within graphs do not differ significantly at the 0.05% level of probability based on Duncan's multiple range test.

Disease	*Befor administration*	*After administration*	*Improvement (%)*
Mean number of people have illness	5.33[a]	3.7[b]	30.58
Mean days lost by illness	34.8[a]	24.2[b]	30.45
Mean of spend for cure (L.E/ family/ year)	1023.33[a]	740.15[b]	27.68
Mean number go to health care center	33.6[a]	21.1[b]	37.20

Mehrandish *et al.* (2019); Deeb *et al.* (2013) and Mehrandish *et al.* (2019) assumed that most people favor to rely on herbs as a daily vitamin and nutrients; as they are very powerful in removing and cleaning body from toxins. Firstly, people can let down their toxicity load by avoiding exposure to toxins as it is possible, and then utilize herbs. The perfect time for cleansing bodies from several toxins by using herbs is spring; as several herbs have effective cleaning aptitudes to detoxify bodies at this time. ABCOSTU is the herbal form applied in the present study is composed of seven herbs (*Arctium lappa*, Berberis vulgaris, *Coriandrum sativum*, *Olea europaea*, *Silybum marianum*, *Tribulus terrestris*, as well as *Urtica dioica*) which are considered as very powerful detox herbs. Most of these herbs can be administrated as teas which individual can drink in a regular basis. **El-Darier *et al.* (2016) and Mohaddese (2021)** recommended that *Arctium lappa* is very effective detoxifier as it has the ability to purify blood. **Sreelatha *et al.* (2009)** also recommended *Coriandrum sativum* as it can help the body to remove the heavy metals, protect it from the oxidative stresses as well as food poisoning, prevent occurring any infections urinary tract and settle down the digestive system. While, **Hashmi *et al.* (2015) and Satarug *et al.* (2018)** suggested that leaves of *Olea europaea* was used as medicinal plants from ancient years. Cadmium is classied as carcinogenic metal from class I that possessed adverse possessions on several body organs such as bones, lungs and kidneys **(Ranieri *et al.*, 2019).**

Data in **Figure 3** showed that about 95.2% of the population possessed food poisoning and about 83.3% had lung diseases who lived close to the factory, also data revealed that there is a noticeable enhancement in Mean values (%) of several common diseases amongst the native people inhabit the study sites close to cement factory after herbal formula administration for six months **(Table 5)**

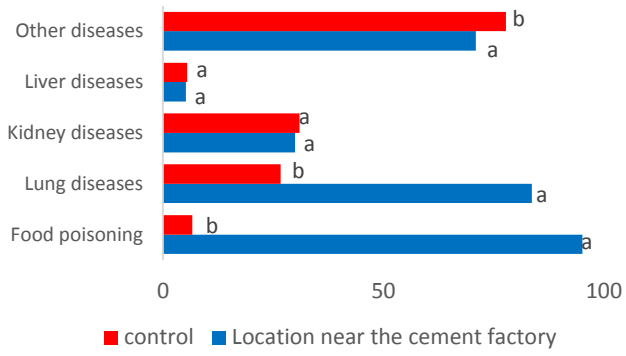

Figure 3. Mean values of some common diseases among inhabitants in control and sample site in the location near the cement factory, means with identical letters within graphs do not differ significantly at the 0.05% level of probability based on Duncan's multiple range test.

Table 5. Mean values (%) of some common diseases among inhabitants in the study site in the location near the cement factory after administration of the herbal formula for six continual months and their percentages of improvement. Means with identical letters within graphs do not differ significantly at the 0.05% level of probability based on Duncan's multiple range test.

Disease	**Befor administration**	**After administration**	**Improvement (%)**
Food poisoning	95.2[a]	61.7[b]	35.19
Lung diseases	26.7[a]	69.2[b]	17.32
Kidney disease	30[a]	22.7[b]	24.33
Liver diseases	5.5[a]	1.7[b]	32.23
Other diseases	71[a]	61[b]	14.08

Conclusion

In conclusion, there is an urgent need to suggest technical and biological solutions in line with the 2030 Agenda to solve the problem of heavy metals in the study area; consequently, modification of the herbal formula and dose can be carried out to help inhabitants of these areas.

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