Journal of science faculty at Sirte University
JSFSU
2021
Peer-review Periodical Journal

جامعة سرت
Sirte University
1989

ISSN INTERNATIONAL STANDARD SERIAL NUMBER
eISSN: 2789-858X

SCIENTIFIC JOURNAL FOR THE FACULTY OF SCIENCE – SIRTE UNIVERSITY

DOI: 10.37375/issn.2789-858X – Indexed by Crossref, USA

VOLUME 3 ISSUE 1 APRIL 2023

Bi-Annual, Peer- Reviewed, Indexed, and Open Accessed e-Journal

SJFSSU

معامل التأثير العربي = 1.02

Legal Deposit Number@NationaL Library (Benghazi): 990/2021

Sjsfsu@su.edu.ly
journal.su.edu.ly/index.php/JSFSU

Scientific Journal for the Faculty of Science-Sirte University Vol. 3, No. 1 (2023) 47-53

Scientific Journal for the Faculty of Science-Sirte University

Journal home page: http://journal.su.edu.ly/index.php/JSFSU/index

DOI: 10.37375/issn.2789-858X

Evaluation of the Healthy of Workers in the Three Cement Factories of Expansion Badoush, New Badoush and Al-Rafidain in Nineveh Governorate

Aya A. H. Rasheed[1], Luay A. Al-Helaly[2], Ayad F. Qasim[1]

[1,3]*Environment Science Department, Environment and Its Technologies College, Mosul University, Mosul, Iraq.*

[2]*Chemistry Department, Science College, Mosul University, Mosul, Iraq.*

DOI: https://doi.org/10.37375/sjfssu.v3i1.1169

ARTICLE INFO:

Received: 15 March 2023
Accepted: 21 March 2023
Published: 17 April 2023

Keywords:
Cement Factory, Pollution, Blood, Enzymes, Kidney, Antioxidants, Oxidative Stress.

A B S T R A C T

The current study involved an assessment of the health of workers in three cement production plants and a comparison between them, as these factories were: Expansion Cement Factory, New Badoush cement factory, and Al-Rafidain cement factory in Nineveh Governorate, as blood samples were collected for a period from the beginning of August to the end of December (2022), The study include was (100) workers and for a control group (40), as the study aimed to know the effect of air pollutants on the workers by measuring (15) variables of different blood components (White blood cell (WBCs), red blood cell (RBCs), packed cell volume (PCV%), hemoglobin (Hb) concentration), platelet count (PLTs)), as well as measuring biochemical variables to evaluate kidney and liver functions, oxidants antioxidants status.

It was observed that there was an increase in the number of both WBC and PLTs Among the three cement workers, especially the Badoush cement factory workers, and there was a reduction in the number of RBC, Hb concentration and PCV% in all cement workers relative to the control group, decrease it was more severe on Badoush workers.

The results indicated a rise in the concentrations of urea and creatinine among the three cement workers, especially the Badoush cement factory workers, and less so among the Al-Rafidain workers, as well as an increase in the enzymes: CA, AST, ALT and ALP when compared with the control team.

It was observed that there was the rise on the state of oxidative stress for the workers in the three factories and it was the highest among the workers in Badoush, Al-Rafidain, and Expansion factories, respectively, as a result of a decrease in the levels of antioxidants and an increase in the levels of oxidants when compared with the control group.

In general, the study concluded that there is a clear Impact of cement pollutants on the workers' health in the three selected cement factories in Nineveh Governorate, and it was more affected by these pollutants on the workers of Badoush Cement, Expansion, and Al-Rafidain, respectively.

1. Introduction

Human health grows and becomes healthy in the degree of safety and hygiene of the environment in which it lives the more pollution in the environment in which it lives the more vulnerable it becomes. Environmental pollution, which is regrettably accelerating in our environment today and for many reasons jumps foremost in terms of technological acceleration, excessive use of natural resources, and terrible emission of gases and vapors from factory towers, has caused significant pollution in the environment (Skalny et al., 2021).

The industry of cement is regarded as a vital, economic, and strategic industry all over the world because this industry is a pillar of the infrastructure of the states and also it meets the demand and needs for cement, which is so important in construction due to the

Corresponding author: E-mail: *luayhelaly@uonosul.edu.iq*

constant urban movement and development. However, at the same time, it is deemed an industry that causes pollution to the environment, particularly the air; inside the factory environment or outside in the environment that surrounds the factory due to the dust and gases emitted because these are released into the atmosphere from the quarries through all the production units at the factory, as a result handling the rocks and soil, which are the primary and raw materials. These are crushed and milled to be ready to enter the furnaces and these processes result in huge quantities of suspended materials. After the clinker from the kiln, comes the process of grinding causes which causes the generation of fine suspended dust and it followed by the cement filling process and loading it. The atmosphere in this unit involves high concentrations of fine suspended material produced (Al-Ahmady, and Obeed, 2015).

The pollution caused by suspended dust or suspended particles is one of the pollution aspects that is worthy to be paid attention as a result to the particles, particularly, those that can be easily inhaled, cause hazards to the environment, the atmosphere, and humans that are characterized by a diameter that is less than 10 microns can absorb toxic substances more compared to their coarse counterparts and get to the human body, then stay with stability in the lungs during the breathing process and they could cause many diseases that affect of the human respiratory system and can also cause cardiac diseases (Mahmmoud and Muwafaq, 2021; Al-Helaly, 2022).

Exposure to fine particulate matter (PM2.5) air pollution originating from the combustion of fossil fuels is closely linked to the induction of both systemic inflammation and oxidative stress among the numerous air pollutants(Maciejczyk et al., 2021). The postulated mechanism is that fossil fuel particulate matter, particularly coal combustion PM2.5, is high in both metals and sulfur which can produce oxidative stress, and sulfur, which causes acidity, increasing the bioavailability of reactive metals and causing systemic damage (Rosenbauer et al., 2016; Al-Helaly and Mahmood, 2019). The oxidative capacity of PM2.5 can be assessed by its ability to form hydroxyl radicals ($^{\bullet}OH$) in the presence of hydrogen peroxide which in turn plays an active role in inducing oxidative stress (Ullah et al., 2021).

The human hemopoietic system knows to be highly sensitive to environmental effects due to quick synthesis and destruction of cells with consequent heavy metabolic demands, which makes it the best indicator in toxicological research (Scharf et al., 2020).

The study of (Al-Shamery and Jankeer, 2021) is among the studies in this domain, which is the effect of exposure to cement dust on the hematological variables in the workers of the new Badoush cement factory in Mosul City, Iraq. However, Al-Hayali and his group (2012) study on the cement pollutants' effect on creatine and urea in the workers' blood serum as they work in the Hammam Al-Alil cement factory, which increases the concentration of urea and a decrease in the creatine concentration. Whereas Nwafor et al. (2019) study the effects of cement dust exposure on haematological indices, and heavy metal cases in the blood serum of rats, Results showed a significant increase in concentrations of calcium, silicon, manganese, iron, lead, and cadmium compared with unexposed animals. Significant reductions were observed in hematocrit values, and red and white blood cell counts after cement dust exposure.

Study the impact of some contaminants emitted by the cement labs in the Badoush region (Badoush Cement Expansion Plant, Badoush New Cement Plant, and Al-Rafidain Cement Factory) on workers' health, their impact on certain blood components and many biochemical variables in serum, and study the extent of oxidative stress events due to exposure of workers in these contaminants and compare compared to the health group.

2. Materials and Methods

The present study was conducted at the Northern State Company of Cement:

1-Study sites: The present study was performed at the Northern State Company for Cement Industry in Badoush Expansion Factory, Badoush New Factory, Al-Rafidain Factory (Old Badush) that is located about 25 km north of Mosul city in Hamidat District. The study sites in these cement production plants are divided into five locations: Management Unit, Crusher Unit, Material Mills Unit, Furnace Unit, and Cement Packaging Unit.

2- Collection of Samples: Throughout this study, blood samples were taken from the employees for the period from the beginning of August until the end of December 2022. The employees are male workers who work in cement production plants (100) and the healthy group (40) (as the control group).

3-Blood tests: which included (White blood cells count (WBCs), red blood cells (RBCs) count, the concentration of hemoglobin (Hb), packed cell volume (PCV%), platelet count (PLTs) using a Sysmix coulter (Sysmex Corporation/Japanese), Principles of measurement Blood is sampled, and diluted, and moves through a tube which is thin enough that cells pass by one at a time. Characteristics of the cell are measured using lasers (Fluorescence flow cytometer) or electrical impedance, in addition to estimating the concentrations of some biochemical variables including evaluating kidney and liver functions (Urea, Creatinine, Albumin**,** Alanine aminotransferase (ALT), Aspartate aminotransferase (AST), Alkaline phosphatase (ALP)

using a FUJI NX500 device, It is made by from the Japanese company Fujifilm and respiratory functions enzyme activity (Carbonic anhydrase) using an ELISA device depends on the use of antibodies, the color change in identifying the presence of the enzyme in the sample, and assessment of antioxidant status by measuring the concentration of glutathione (GSH), Malondialdehyde (MDA), Peroxynitrite ($ONOO^-$) nitrate in the serum of the blood using a Spectrophotometer were determined using manual methods (Table 1).

2.2: Statistical analysis

The he Statistical analysis was conducted by means of using the Statistical Package for Social Sciences (SPSS), Version 24. Data were demonstrated as arithmetic mean and standard error (mean ± SE). The complete Randomized Design (C. R. D.) test was performed make a comparison between the groups and the value p-value of ≤ 0. 05 as it is depended as the significance level.

Table 1: Methods used to determine biochemical parameters.

No.	Parameters measured	Method used
1	Urea	Depending on the enzymatic method (Friedman and Brandon, 2001)
2	Creatinine	(Jaffe method, 1886)
3	Albumin	Bromocresol green method (Doumas *et al*., 1971)
4	Alanine aminotransferase (ALT)	BIOMERIEUX Company/France kit (Reitman and Frankel, (1957).
5	Aspartate aminotransferase (AST)	BIOMERIEUX Company/France kit (Reitman and Frankel, 1957).
6	Alkaline phosphatase (ALP)	BIOMERIEUX Company/France kit (Kind and King, 1954)
7	Glutathione (GSH)	Modified procedure utilizing DNTB reagent (Sedlak and Lindsay, 1968)
8	Malondialdehyde(MDA)	Thiobarbituric acid method (Janero, 1990)
9	Peroxynitrate (ONOO-)	Vanuffelen Method used (Vanuffelen *et al*., 1998)
10	Carbonic anhydrase (CA)	Use of enzyme-related industrial adsorption technology (Enzyme – Linked Immuno sorbent ASSAY) (ELISA)

3. Results and Discussion

1. The effect of cement pollutants on the workers of the three cement factories on different blood components (Number of WBCs, RBCs, PLTs, and concentration of Hb, and PCV%):

Table (2) shows the effect of cement pollutants in the workers of the three cement factories on the components of the workers' blood at selected sites: Management Unit, Crusher Unit, Material Mills Unit, Furnace Unit, and Cement Packaging Unit (Badoush expansion, Badoush new and Al-Rafidain) in comparison to the control group.

Table (2): Comparison of blood component levels between the control group with workers in the three cement factories.

Blood components	Control group		Workers' Group (Badoush Expansion)		Workers' Group (new Badoush)		Workers' Group (Al-Rafidain)	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Age (year)	33.5 **a**	1.16	35.28 **a**	1.93	33.32 **a**	1.75	35.04 **a**	**2.58**
BMI(kg/m^2)	25.8 **a**	1.05	26.47 **a**	1.059	26.37 **a**	1.059	26.97 **a**	**1.44**
WBC (×^{3}10/L)	8.01 **a**	0.79	8.65 **b**	0.403	9.13 **c**	0.19	8.67 **b**	**0.33**
RBCs(×^{6}10 /L)	4.56 **d**	0.33	3.59 **c**	0.18	2.21 **a**	0.202	2.89 **b**	**0.21**
Hb (gm/100ml)	14.86 **d**	0.50	13.32 **c**	0.47	12.22 **a**	0.27	13.02 **b**	**0.64**
PCV %	49.40 **d**	3.17	45.5 **b**	1.36	42.35 **a**	1.50	46.4 **c**	**1.58**
PLTs(× ^{3}10/L)	194.5 **a**	9.49	218.8 **c**	13.60	252.8 **d**	16.99	216.8 **b**	**11.02**

-Variation of letters (a, b, c, d) horizontally indicates that there is a significant difference at a lower probability level or equal to 0.05.

Results illustrate that there was a significant difference ($p \leq 0.05$) in terms of the numbers of WBCs, RBCs, PLTs, the concentration of Hb, and PCV%. It was noted that there is a significant decrease in three groups of workers and the highest WBCs at 9.13 ($\times 10^3$/L) and PLTs at 252.8 ($\times 10^3$/L) in the new cement Badoush plant and no significant difference between the cement Al-Rafidain plant and cement Badoush expansion plant was recorded in the number of WBCs at 8.6 ($\times 10^3$/L) compared to the control group in the number of WBCs by 8.01 ($\times 10^3$/L) and PLTs at 194.5 ($\times 10^3$/L).

The cause is thought to be an increased activity of phagocytic cells as a result of the occurrence of pulmonary infections after inhaling dust. This activity stimulates the bone marrow to release polymorphonuclear (PMN) is immature in large quantities that raise the numbers of WBCs (Losacco *et al*., 2018).

The cause of platelet increase (PLT) in the current study is a lack of oxygen due to the reaction from cement dust irritating cells in the lung (Ewaid *et al*., 2020). This result is consistent with the Poursafa researcher and others (2011), it was found an increase in the number of platelets after exposure to air pollutants in children and adolescents in the city of Isfahan.

While a significant decrease in number of RBCs, Hb concentration and PCV was observed in workers' groups and was the lowest concentration in the workers of the new cement plant Badoush compared with control group (Number of RBCs at a rate of 4.56 ($\times 10^6$/L), Hb concentration at 14.86 (g/100 ml) and PCV at 49.40% , The reason for this may be attributed to the decrease in the number of red blood cells to the body's responses to irritation resulting from cement pollutants (Adeyanju and Okeke, 2019), as well as the decrease in the concentration of PCV% and Hb exposed to cement dust due to the negative correlation between the components of the blood and the exposure to pollutants, as the exposure is with chronic condition and the workers are exposed to substances that are toxic resulting from the silica cement components and these involve calcium oxide, aluminum oxide, and hexavalent chromium and they can result in various infections and thus lead to a decrease in hemoglobin production (Al-Shamery and Jankeer, 2021).

2. Effect of cement pollutants on the workers of the three cement factories on the levels of (CA, AST, ALT, ALP) enzymes, urea, and creatinine:

Table (3) shows the impact of cement contaminants on the workers of the three cement factories on the levels of (CA, AST, ALT, ALP) enzymes, urea, and creatinine at selected sites: Management Unit, Crusher Unit, Material Mills Unit, Furnace Unit and Cement Packaging Unit (Badoush expansion, new Badoush, and Al-Rafidain) compared with the control group.

Table 3: Comparison of levels of (CA, AST, ALT, ALP) enzymes, urea and creatinine between control group with workers in the three cement factories.

Blood components	Control group		Workers' Group (Badoush Expansion)		Workers' Group (new Badoush)		Workers' Group (Al-Rafidain)	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Urea (mg/100ml)	19.97 **a**	1.48	29.16 **c**	1.41	30.11 **d**	1.08	28.07 **b**	**1.92**
Creatinine(mg/100ml)	0.713 **a**	0.08	0.902 **c**	0.031	0.97 **d**	0.024	0.81 **b**	**0.03**
CA (Pg/L)	75.21 **a**	3.2	100.9 **c**	5.53	108.3 **d**	3.76	95.65 **b**	**3.51**
AST (U/L)	21.32 **a**	1.10	27.87 **c**	2.42	29.62 **d**	1.47	26.40 **b**	**1.87**
ALT (U/L)	22.22 **a**	1.75	23.60 **c**	1.21	26.97 **d**	1.52	22.70 **b**	**1.20**
ALP (U/L)	73.66 **a**	3.03	102.3 **d**	7.7	81.76 **b**	4.17	90.54 **c**	**6.38**

- Variation of letters (a, b, c, d) horizontally indicates that there is a significant difference at a lower probability level or equal to 0.05.

Results showed that there is a significant difference ($p \leq 0.05$) in the concentrations of variables and high levels of urea and creatinine were observed among cement workers in the three Factories in comparison to the control group, especially the workers of the new Cement Badoush plant, where the

concentration of urea was recorded at a rate (30.11 mg/100 ml) and the concentration of creatinine at a rate (0.97 mg/100 ml) and less Al-Rafidain workers had a urea concentration record at a rate (28.07 mg/100 ml). High concentration of urea in the serum of workers exposed to dust may be attributed to kidney effect and kidney inefficiency due to exposure to different contaminants and creatine concentration record at a rate (0.81 mg/100 ml) compared to the control group, the main reason for this is the low glomerular filtration rate of nitrogen, which impedes the flow of urine, i.e. dissolution outside the human body, resulting in the accumulation of metabolic waste (Kuraeiad and Kotepui, 2021).

It also recorded a significant rise of enzymes: CA at a rate of 108.3 pg/L and AST (29.62 U/L) and ALT (26.97 U/L) in the new cement Badoush plant and fewer Al-Rafidain workers had a CA concentration record at a rate (95.65 pg/L) and AST enzyme at (26.40 U/L) and ALT at (22.70 U/L), While the ALP enzyme at the cement Badoush expansion plant registered at a rate (102.3 U/L) and said the new cement Badoush workers had a rate (81.76 U/L). The cause of high CA levels is a result of its rise in cells lining pulmonary blood vessels such as epithelial tissue in identity vesicles, due to exposure to various air contaminants. The respiratory system is the only one in the body that is in contact with the air in the peripheral environment. Exposure to these contaminated substances will also lead to oxidative stress resulting from the increased production of oxidant compounds, which have an effect on the outer membrane of the tissue by raising the level of lipid peroxide as a result of the breakdown of cellular membranes in the lung resulting in a change in their susceptibility to selective permeability that frees large amounts of the CA enzyme out of the cell and then into the serum as well as a lack of oxygen (Lakey *et al*., 2016).

On the other hand, the high level of ALP may be caused by the blockage of bile ducts resulting from exposure to cement dust, which may lead to bone deformation and bone cancer can occur as a result of exposure to various contaminants, all of which lead to a high increase in the effectiveness of this enzyme (Sanjel and Shim, 2020), There has also been a significant increase in the activity of the AST in the blood of persons exposed to the dust of the cement, which is likely to cause muscle dysmorphia or heart disorder due to increased blood content in the body, for example, high hemoglobin and PCV as a result of the large body's need for hemoglobin to transport oxygen and compensation for as a result of the presence of dust, all of which causes heart stress due to inhalation of contaminated air containing cement dust (Reda, *et al*., 2021).

The ALT is an indicator of the efficiency of the liver's work, as its increase means that the hepatic cells are destroyed decompose, or die in the event of the death of these cells. ALT is released into the bloodstream and its ratio rises. This increase can be clearly seen in the liver, leading to the release of the enzyme into the serum refers to this researcher (Abdu and Al-Bogami, 2019).

2. Effect of cement pollutants on the workers of the three cement factories on the levels of GSH, MDA, ONOO$^-$ and Alb:

Table (4) shows the effect of cement contaminants on the three cement factories workers at GSH, MDA, ONOO- and Alb levels at selected sites Badoush expansion, new Badoush, and Al-Rafidain compared with the control group.

Table 4: Comparison of GSH, MDA, ONOO- and Alb levels between control group with workers in the three cement factories.

Blood components	Control group		Workers' Group (Badoush Expansion)		Workers' Group (new Badoush)		Workers' Group (Al-Rafidain)	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
GSH(µmol/L)	11.08 **d**	0.62	4.55 **b**	0.97	2.30 **a**	0.44	5.78 **c**	**0.90**
MDA(µmol/L)	3.98 **a**	0.35	5.14 **b**	0.72	6.93 **d**	1.08	5.68 **c**	**0.73**
ONOO-(µmol/L)	56.37 **a**	3.89	59.04 **b**	2.92	72.29 **d**	2.51	68.68 **c**	**2.16**
Alb(gm/100ml)	3.81 **a**	0.21	4.22 **c**	0.14	4.39 **d**	0.17	4.06 **b**	**0.25**

* Variation of letters (a, b, c, d) horizontally indicates that there is a significant difference at a lower probability level or equal to 0.05.

The results indications of a significant decrease in GSH level at a probability ($p \leq 0.05$) in the workers compared with the control group where the highest concentration was recorded in the group of workers of the cement factory Badoush expansion (4.55 µmol/L), Next was the Al-Rafidain cement plant workers group (5.78 µmol/L) and new Badush cement plant workers group (2.30 µmol/L), while the highest concentration of control group was recorded at (11.08 µmol/L).

The reason for the low level of GSH is that it is a protective antioxidant that is involved in the deoxidation

because it can interact directly with radical (•OH) or with hydrogen peroxide (H_2O_2) automatically through thiol group (-SH) containing it in its composition, as well as its use as a substrate in glutathione peroxidase. Therefore it has an important role in protecting cellular components from oxidation compounds (Hazra *et al*., 2013), While it recorded a significant increase in the level of MDA, ONOO- and Alb in workers' blood where it recorded the highest concentrations in the new cement Badoush plant was the concentration of MDA at a rate (6.93 µmol/L), ONOO- at a rate (72.29 µmol/L) and Alb at a rate (4.39 g/100ml), Followed by cement workers Al-Rafidain and cement workers Badoush expansion respectively compared with the control group where MDA concentration (3.98 µmol/L), ONOO- concentration (56.37 µmol/L) and Alb concentration (3.81 µmol/L).

The increase of MDA may be reacted with deoxyadenosine and deoxyguanosine in DNA forming DNA adducts, primarily M1 G, which is mutagenic and may occur in workers in the future.

Recently, ROS have been recognized as important signaling molecules that control diverse signaling pathways involved in a variety of cellular responses such as programmed cell death, pathogen defense, and hormone signaling (Hwa Yun *et al*., 2020). In addition, oxidative stress causes dramatic inhibition of the tricarboxylic acid cycle, glycolysis pathway, and pentose phosphate pathway (Al-Helaly and Ahmad, 2011).

Albumin is a major antioxidant component of plasma. In addition, albumin, one of the most important proteins in human plasma, is able to bind to Cu^{2+} tightly and with iron weakly. Copper bond to albumin is still effective in generating radicals species (Hydroxyl radicals) in the presence of hydrogen peroxide by Fenton reactions. Therefore, increasing it to protect humans from oxidants compounds formation (López-Tinoco *et al*., 2011).

High $ONOO^-$ is caused by cellular destruction occurring under strong oxidation conditions when different contaminants are present and by increasing the formation of $ONOO^-$ participates in the destruction of DNA and the ineffectiveness of certain metabolic enzymes or ion pumps, damaging the cellular membrane (Ascenzi *et al*., 2020).

3. Conclusions

In general, the study concluded that there was a clear impact of cement contaminants on the health status of the workers of the three selected cement factories in Nineveh governorate, and that they were further affected by those contaminants on the Badoush cement workers and its expansion, followed by Al-Rafidain, respectively.

Acknowledgements

The author would like to acknowledge those who always encourage and give their guidance, mom and dad.

References

Abdu, S. B., & Al-Bogami, F. M. (2019). Influence of resveratrol on liver fibrosis induced by dimethylnitrosamine in male rats. Saudi Journal of Biological Sciences, 26(1), 201-209.

Adeyanju, E., & Okeke, C. A. (2019). Exposure effect to cement dust pollution: A mini review. SN Applied Sciences, 1(12), 1572.

Al-Ahmady, K. K., & Muhsin Obeed, H. (2015). Assessment of Air Particulate Pollution in New Badoosh Cement Factory/Iraq. Al-Rafidain Engineering Journal (AREJ), 23(3), 123-135.

AL-Hayali , H.L ; AL-Harbawi , M.K and Ali , s.y (2012) effect of cement pollution on creatinine and blood urea in haman AL-Alil factory workers. College of Basic Education Researeners journal, vol, 11. No 3.

Al-Helaly, L. A., & Ahmad, T. Y. (2011, November). Oxidative Stress for X-Ray Diagnosis Workers in Mosul City. In The Second Scientific Conference in Chemistry (pp. 22-23).

Al-Helaly, L. A., Mahmood, E. S. (2019). Studying of heavy and essential metals in the amniotic fluid for pregnant associated with high blood pressure. Raf. Jour. Sci. 22(1):53-68.

Al-Helaly, L.A. (2022). Mechanism of Toxic Substances Inside Living Organisms, Dar Noun for Printing, Publishing and Distribution, Mosul, Iraq, ISBN: 978-9922-9818-5-7. Pp.167, 175. 194, 206, 213, 223, 220.

Al-Shamery, H. A., & Jankeer, M. H. (2021, September). Study the effect ocement dust exposure on the hematological variables in the workers of new badoosh cement factory in mosul city, Iraq. In Journal of Physics: Conference Series (Vol. 1999, No. 1, p. 012030). IOP Publishing.

Ascenzi, P., De Simone, G., Tundo, G. R., Platas-Iglesias, C., & Coletta, M. (2020). Ferric nitrosylated myoglobin catalyzes peroxynitrite scavenging. JBIC Journal of Biological Inorganic Chemistry, 25, 361-370.

Doumas, B. T., Watson, W. A., & Biggs, H. G. (1971). Albumin standards and the measurement of serum albumin with bromcresol green. Clinica chimica acta, 31(1), 87-96.

Ewaid, S.H.; Abed, S.A.; Al-Ansari, N.; Salih, R.M. (2020) Development and Evaluation of a Water Quality Index for the Iraqi Rivers. Hydrology, *7*(3): 67.

Fairley, T. L., Cardinez, C. J., Martin, J., Alley, L., Friedman, C., Edwards, B., & Jamison, P. (2006). Colorectal cancer in US adults younger than 50 years of age, 1998–2001. Cancer, 107(S5): 1153-1161.

Friedman, M., & Brandon, D. L. (2001). Nutritional and health benefits of soy proteins. Journal of agricultural and food chemistry, 49(3), 1069-1086.

Hazra, B., Sarkar, R., & Mandal, N. (2013). Spondias pinnata stem bark extract lessens iron overloaded liver toxicity due to hemosiderosis in Swiss albino mice. Annals of Hepatology, 12(1), 123-129.

Hwa Yun, B., Guo, J., Bellamri, M., & Turesky, R. J. (2020). DNA adducts: Formation, biological effects, and new biospecimens for mass spectrometric measurements in humans. Mass spectrometry reviews, 39(1-2), 55-82.

Jaffe, M. Z. (1886). Method for measurement of creatinine in serum. Physiol Chem, 10(391), 31.

Janero, D. R. (1990). Malondialdehyde and thiobarbituric acid-reactivity as diagnostic indices of lipid peroxidation and peroxidative tissue injury. Free radical biology and medicine, 9(6), 515-540.

Kind, P.R.N., and King, E.G., 1954. Estimation of Plasma Phosphate by Determined of Hydrolyzed Phenol with Amino Antipyrine. J. Clin. Path., 7: pp.322-326.

Kuraeiad, S., & Kotepui, M. (2021). Blood lead level and renal impairment among adults: A meta-analysis. International journal of environmental research and public health, 18(8), 4174.

Lakey, P. S., Berkemeier, T., Tong, H., Arangio, A. M., Lucas, K., Pöschl, U., & Shiraiwa, M. (2016). Chemical exposure-response relationship between air pollutants and reactive oxygen species in the human respiratory tract. Scientific reports, 6(1), 16.

Lopez-Tinoco C, Roca M, Garcia-Valero A, Murri M, Tinahones FJ, Segundo C, Bartha JL, Aguilar-Diosdado M. (2013) Oxidative stress and antioxidant status in patients with late-onset gestational diabetes mellitus. *Acta Diabetol.* 50:201–208.

Losacco, C., & Perillo, A. (2018). Particulate matter air pollution and respiratory impact on humans and animals. Environmental Science and Pollution Research, 25, 33901-33910.

Maciejczyk, P., Chen, L. C., & Thurston, G. (2021). The role of fossil fuel combustion metals in PM2. 5 air pollution health associations. Atmosphere, 12(9), 1086.

Mahmmoud, I. M., & Muwafaq, A. R. (2021). The Impact of Badoush Cements Factory Pollutant on the Health of Workers in It. Annals of the Romanian Society for Cell Biology, 14711-14724.

Nwafor, P. C., Odukanmi, O. A., Salami, A. T., Owonikoko, M., & Olaleye, S. B. (2019). Evaluation of a cement dust generation and exposure chamber for rodents: blood heavy metal status, haematological variables and gastrointestinal motility in rats. African Journal of Biomedical Research, 22(1), 79-87.

Poursafa, P., Kelishadi, R., Moattar, F., Rafiee, L., Amin, M. M., Lahijanzadeh, A., & Javanmard, S. H. (2011). Genetic variation in the association of air pollutants with a biomarker of vascular injury in children and adolescents in Isfahan, Iran. Journal of Research in Medical Sciences: The Official Journal of Isfahan University of Medical Sciences, 16(6), 733.

Reda, F. M., El-Saadony, M. T., El-Rayes, T. K., Attia, A. I., El-Sayed, S. A., Ahmed, S. Y., ... & Alagawany, M. (2021). Use of biological nano zinc as a feed additive in quail nutrition: biosynthesis, antimicrobial activity and its effect on growth, feed utilisation, blood metabolites and intestinal microbiota. Italian Journal of Animal Science, 20(1), 324-335.

Reitman, S., & Frankel, S. (1957). A colorimetric method for the determination of serum glutamic oxalacetic and glutamic pyruvic transaminases. American journal of clinical pathology, 28(1), 56-63.

Rosenbauer, J., Tamayo, T., Bächle, C., Stahl-Pehe, A., Landwehr, S., Sugiri, D., & Rathmann, W. (2016). Re: ambient air pollution and early manifestation of type 1 diabetes. Epidemiology, 27(4), e25-e26.

Sanjel, B., & Shim, W. S. (2020). Recent advances in understanding the molecular mechanisms of cholestatic pruritus: A review. Biochimica et Biophysica Acta (BBA)-Molecular Basis of Disease, 1866(12), 165958.

Scharf, P., Broering, M. F., Oliveira da Rocha, G. H., & Farsky, S. H. P. (2020). Cellular and molecular mechanisms of environmental pollutants on hematopoiesis. International Journal of Molecular Sciences, 21(19), 6996.

Sedlak, J., Lindsay, R. H. (1968). Estimation of total, protein bond and non-protein sulfhydryl groups in tissue with Ellman's reagent. Anal. Biochem. 25, 192-205.

Skalny, A. V., Aschner, M., Bobrovnitsky, I. P., Chen, P., Tsatsakis, A., Paoliello, M. M., & Tinkov, A. A. (2021). Environmental and health hazards of military metal pollution. Environmental Research, 201, 111568.

Ullah, I., Zahid, M., Jawad, M., & Arsh, A. (2021). Assessment of DNA damage and oxidative stress among traffic conductors and coal miners. Pakistan Journal of Medical Sciences, 37(2), 499.

Vanuffelen, B.E.; J. Van der Zee, B.M. deKoster, J. VanStereninck and Elferink, J.G. (1998). Intracellular but not extracellular conversion of nitroxyl anion into nitric oxide leads to stimulation of human neutrophil migration. Biochem. J., 330: 719-722.

Scientific Journal For the Faculty of Science – Sirte University

Sjsfsu@su.edu.ly

journal.su.edu.ly/index.php/JSFSU