Study the effect of cement dust exposure on the hematological variables in the workers of new badoosh cement factory in Mosul city, Iraq

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Abstract: The present study was carried in the New Badoosh Cement factory in Mosul city belonged to Ministry of Industry and Minerals / Iraq. The continuous exposure to cement dust leads to many respiratory and health problems. So the current study aimed to determine the negative effects of this dust and the continuous exposure to them in hematological variables in the blood of 150 workers of non-smoking males working, by 25 blood samples for each of the units and productive stages as following: The administrative unit (indirect exposure group), and the groups of the productive stages (direct exposure), which included stage of mechanical workshop, material milling, ovens, cement milling and packing. Their ages ranged between (23-59) years, exposure periods were divided according to the working years into (5-10), (11-20) and (>20) years, then comparison with 30 healthy, non-smoking males of the same age as workers residents in the Rabea sub-district (Al-Owainat village) outside the city and were used as a control group. The results showed a significant decrease in the hemoglobin concentration (Hb), packed cell volume (PCV%) and red blood cells count (RBCs). Also the results showed a significant increase in count of white blood cells (WBCs), lymphocytes and granules in the blood of workers in administrative unit (indirect exposure group) and indifferent productive stages (direct exposure group) during the three exposure periods, as these results showed that different exposure periods and special (>20) years had a clear effect on these studied blood components. It is concluded from this study that exposure of workers in different productive stages and administrative unit to cement dust has caused clear negative effects on the blood components with an increase in the exposure period and a disrupted in metabolic and physiological processes.

Keywords: Cement dust, blood components, Red Blood Cells (RBCs), White Blood Cells (WBCs).

1. Introduction

Industrial pollution is defined as is it the damage to the ecosystem as a result of the industrial activity of different professions and industrial institutions and diminishes its ability to provide a healthy life physically, psychologically, socially and ethically for a human, meaning that industrial pollution produces from human’s act and activity and finds its source in industrial, service, recreational and other activities[1]. So industry is one of the most important sources that produce various pollutants and this is due to the tremendous progress and multiplicity of industries in our modern world. There are three main methods of exposure to these pollutants and their entry into the human body,
According to the type and concentration of the pollutant and the duration of exposure to it: inhalation, swallowing, and then absorption. As chemical pollutants from various industries can accumulate in the cells and tissues of living organisms until they reach the degree of toxicity [2].

The cement industry is considered one of the important strategic and economic industries in the world, as it contributes to the country's infrastructure, in addition to filling the need for this important material in construction due to the continuous development and urban movement, but at the same time it is considered one of the industries polluting the environment, especially the air, whether inside the factory environment or in the surrounding environment due to the gases and dust that it releases into the atmosphere from the quarries through all the productive sections of the factory, as a result of its handling of soil and rocks as a primary material, as it is crushed and milled to prepare it to enter the furnaces and these processes produce large quantities of suspended materials, and after the clinker from the kiln is the process of grinding Causes the generation of fine suspended dust, followed by the process of filling and loading cement, and the atmosphere of this unit has high concentrations of fine suspended matter production[3]. The cement is a dark grey, colored powdery substance of alumina oxide, lime, silica, calcium, magnesium oxide and iron mainly, in addition to trace elements, such as lead, zinc, copper, chromium, cobalt and nickel, which are found in small stones and clay. It comes into contact with it during the manufacturing or packing stages, either directly or on a spray flying with dust [4, 3, 5, 6].

Cement minutes resulting from grinding and other processes directly and specifically affect human health, in addition to their negative impact on the environment and occur in cases of stoppage or non-use of electrostatic precipitators, as two types of pollutants are emitted from cement factories: particulate pollutants and gaseous pollutants that include Sulfuroxides(SOx), Nitrogen oxides (NOx), Carbon monoxide (CO), Hydrocarbons, Fumes[7, 8].

Exposure to flying dust leads to many serious health diseases, especially the respiratory system, bronchial asthma, emphysema and pulmonary damage caused by inhaling dust, in addition to prolonged exposure to dust, which affects the sense of taste, smell, skin, eyes and hematological systems [9, 5, 10]. The findings of study in India and Nigeria also suggest that cement dust exposure caused haematologic and cytogenetic damage in cement factory workers [11, 12, 9, 5, 13].

The present study aimed to know the effect of cement dust during the cement production stages on the hematological variables of workers exposed to it during their daily work and for different annual exposure periods compared to a control group (healthy people). In order to determine the negative impact of dust on the health and safety of workers.

2. Materials and Methods

2.1 Samples collection

The current study was conducted in the New Badoosh Cement Factory in the Mosul city, belonging to the Ministry of Industry and Minerals / Iraq, which is located at 25 km west of the Mosul city in Hamidat district, as it produces ordinary Portland cement by the dry method. In this study, 150 blood samples of non-smoking male workers were collected, by 25 blood samples for each unit and stages of production, as following: The administrative unit (indirect exposure group), and groups of productive stages (direct exposure), which included the mechanical workshop stage, materials milling, ovens, cement milling and packing of cement. Their ages ranged between (23-59) years. Exposure periods were divided according to the working years into (5-10), (11-20) and (> 20) years, then comparison to 30 healthy, non-smoking males, with the same age of workers residents in Rabea sub - district (Al-Owainat village) outside the city, and were used as a control group. Information was collected from workers and healthy people according to the questionnaire form for each person, which includes the name, age, housing location, work location (in any unit or production stage) and the number of years of work or service.
2. 2 Collect blood samples
Withdraw (1-2) ml of venous blood and put it in a plastic tube containing EDTA an anti-coagulant, and it was used for estimation hematological variables, which includes hemoglobin concentration (Hb), Packed Cell Volume (PCV%), Red Blood Cells count (RBCs), White Blood Cells count (WBCs), lymphocytes and granules count. The collected blood sample was analyzed with automated hematology analyzer type of Rayto( RT-7600).

Statistical analysis
Statistical analysis was performed by using statistical program ready SPSS(Statistical Package for Social Sciences) Version 24. Data were presented as mean and standard deviation (mean ± SD). The complete Randomized Design (C. R. D. ) test was done to compare between the groups and p value of ≤ 0.05 was taken as level of significance.

3. Results

3. 1 Hematological variables

3. 1. 1 Hemoglobin concentration (Hb) and Packed Cell Volume (PCV)
The results in table (1and 2) showed the effect of cement dust on the hemoglobin concentration (Hb) and percentage of Packed Cell Volume (PCV%) in the blood of workers in the production stages for New Badoosh Cement factory, and for different exposure periods. The results showed a significant decrease(P≤0.05) in Hb concentration and PCV% in the blood of all workers exposed to cement dust in different production stages or all units in factory compared with the control group. The highest percentage of decrease in Hb concentration and PCV%for the period of exposure ( >20 ) year in the blood of workers (direct exposure group) in the mechanical workshop unit 21%, the material milling and cement milling units 19%, packing 10%, ovens 9%, 10% respectively, followed by administrators(indirect exposure group) 7% compared with the control group. From this results it was found that the percentage of decrease in Hb concentration and PCV increases with increasing exposure periods.
### Table 1: The effect of cement dust on some hematological variables of workers in the production stages for the new Badoosh cement Factory and for different exposure periods

| Exposure Period | Variable | (4-10) Year | (11-20) Year | (>20) Year |
|-----------------|----------|-------------|-------------|-----------|
|                  | Conc. | Change | Conc. | Change | Conc. | Change |
|                  | Mean±SE | % | Mean±SE | % | Mean±SE | % |
| Control          | 155.7±1.86 | 100 | --- | --- | 155.7±1.86 | 100 |
| Indirect exposure | Administr- atorn | 146.3±2.19 | 94 | -6 | 146.7±2.40 | 94 | -6 | 145.0±1.52 | 93 | -7 |
| Stage 1          | 144.0±1.53 | 92 | -8 | 136.7±4.48 | 88 | -12 | 123.7±6.39 | 79 | -21 |
| Stage 2          | 138.7±0.33 | 89 | -11 | 131.7±0.88 | 85 | -15 | 125.7±1.20 | 81 | -19 |
| Stage 3          | 144.7±0.33 | 93 | -7 | 143.0±1.15 | 92 | -8 | 141.0±0.58 | 91 | -9 |
| Stage 4          | 138.3±1.76 | 89 | -11 | 133.3±1.20 | 86 | -14 | 126.7±0.88 | 81 | -19 |
| Stage 5          | 147.3±1.20 | 95 | -5 | 143.0±1.00 | 92 | -8 | 139.7±1.20 | 90 | -10 |

*The numbers followed by vertically different letters indicate the presence of significant differences between them at the probability (p≤0.05) and vice versa according to the Duncan's test. Stage 1: Workers in mechanical workshop; Stage 2: Workers in material milling; Stage 3: Workers in ovens; Stage 4: Workers in cement milling; Stage 5: Workers in packing. The sign (−) is mean an decrease.
Table (2): The effect of cement dust on some hematological variables of workers in the production stages for the new Badoosh cement Factory and for different exposure periods

| Variable | Exposure Period | Packed Cell Volume PCV (%) |
|----------|-----------------|----------------------------|
|          | (4-10)Year      | Mean±SE | Change % | (11-20)Year | Mean±SE | Change % | (>20)Year | Mean±SE | Change % |
| Control  |                 | 47.20±0.56 | 100      |             |          |          |           |          |          |
| Indirect exposure | Adminstrators | 44.33±0.68 | 94      | -6          | 44.43±0.74 | 94      | -6          | 43.90±0.46 | 93      | -7          |
| Stage 1  | Direct exposure | 43.60±0.46 | 92      | -8          | 41.40±1.35 | 88      | -12         | 37.47±1.95 | 79      | -21         |
| Stage 2  | 42.00±0.10      | 89      | -11         | 39.90±0.26 | 85      | -15         | 38.13±0.39 | 81      | -19         |
| Stage 3  | 43.80±0.10      | 92      | -8          | 43.30±0.35 | 92      | -8          | 42.70±0.17 | 90      | -10         |
| Stage 4  | 41.90±0.53      | 89      | -11         | 40.40±0.35 | 86      | -14         | 38.40±0.26 | 81      | -19         |
| Stage 5  | 44.63±0.38      | 95      | -5          | 43.30±0.30 | 92      | -8          | 42.30±0.36 | 90      | -10         |

*The numbers followed by vertically different letters indicate the presence of significant differences between them at the probability (p≤0.05) and vice versa according to the Duncan's test. Stage 1: Workers in mechanical workshop; Stage 2: Workers in material milling; Stage 3: Workers in ovens; Stage 4: Workers in cement milling; Stage 5: Workers in packing. The sign (−) indicates a decrease.

3.2 Red Blood Cells Count (RBCs)

Table (3) showed the effect of cement dust on the Red Blood Cells count (RBCs) in the blood of workers in the production stages for New Badoosh Cement factory for different exposure periods. The results showed a significant decrease (P≤0.05) in RBCs count in the blood of all workers exposed to cement dust in different production stages or all units in factory compared with the control group. The results showed a significant decrease in RBCs count for the period of exposure (11-20) and (>20) year in the blood of workers in all factory units, where the highest percentage of effects in direct exposure groups such as material milling 17%, 33% and cement milling 19%, 31%, and followed by packing 14%, 20%, ovens 14%, 17%, mechanical workshop 14%, 16% and finally administrators (indirect exposure group) 10%, 12%, respectively compared with the control group. From this study it was found that the percentage of decrease RBCs count increases with increasing exposure periods.

3.3 White Blood Cells Count (WBCs)

Table (4) showed the effect of cement dust on the White Blood Cells count (WBCs) in the blood of workers in the production stages for New Badoosh Cement factory for different exposure periods. The results showed a significant increase (P≤0.05) in WBCs count in the blood of all workers exposed to cement dust in all the different administrative and production units in the factory and for different exposure periods compared with the control group. The results of this study showed a significant increase (P≤0.05) in WBCs count in blood workers for the duration of exposure (11-20) year in cement factory units (direct exposure groups) include cement milling, material milling, mechanical workshop, ovens, packing and administrators (indirect exposure group) by 44%, 41%,
26%, 23%, 17%, 10% respectively, compared with the control group. The highest percentage of increase in WBCs count for the period of exposure (>20) year in the blood of workers (direct exposure groups) in the materialmilling unit 60%, cement milling 57%, packing 41%, mechanical workshop 34%, ovens 28% and followed by administrators (indirect exposure group) 23%, compared with the control group, which is the longest exposure period.

3. 4 Lymphocytes and Granules Count

The results in table (5 and 6) showed the effect of cement dust on the lymphocytes and granules count of WBCs in the blood of workers in the production stages for New Badoosh Cement factory for different exposure periods. The results showed a significant increase (P≤0.05) in lymphocytes and granules count of WBCs in the blood of all workers exposed to cement dust in all the different administrative and production units in the factory and for different exposure periods compared with the control group. The highest percentage of increase in lymphocytes count for the period of exposure (>20) year in the blood of workers (direct exposure groups) in the materialmilling unit 68%, ovens 61%, cement milling 58%, mechanical workshop 43%, packing 41%, and followed by administrators (indirect exposure group) 26%, compared with the control group, which is the longest exposure period.

The results of this study showed, a significant increase (P≤0.05) in granules count in blood workers for the duration of exposure (>20) year in cement factory units include cement milling, packing, material milling, ovens, mechanical workshop and administrators by 24%, 24%, 25%, 19%, 18%, 10% respectively, compared with the control group. From this study it was found that the WBCs, lymphocytes and granules count increases with the increase in exposure periods.

### Table 3

| Exposure Period | Red Blood Cells count RBCs(*10^12/L) | (4-10)Year | (11-20)Year | (>20)Year |
|-----------------|-------------------------------------|------------|-------------|-----------|
|                 | Mean±SE | Change | Mean±SE | Change | Mean±SE | Change |
| Control group   | 4.96±0.05 | 100 | 4.96±0.05 | 100 | 4.96±0.05 | 100 |
| Indirect exposure | 4.73±0.15 | ab | 4.44±0.09 | cd | 4.37±0.03 | de |
| Stage 1         | 4.31±0.19 | def | 4.27±0.04 | def | 4.17±0.13 | d-g |
| Stage 2         | 4.27±0.01 | def | 4.12±0.06 | efg | 3.32±0.04 | h |
| Direct exposure | 4.36±0.01 | de | 4.28±0.04 | def | 4.12±0.05 | efg |
| Stage 3         | 4.29±0.03 | def | 4.02±0.04 | fg | 4.43±0.09 | h |
| Stage 4         | 4.68±0.01 | bc | 4.25±0.09 | d-g | 3.98±0.19 | -g |
| Stage 5         | 4.73±0.15 | ab | 4.44±0.09 | cd | 4.37±0.03 | de |

*The numbers followed by vertically different letters indicate the presence of significant differences between them at the probability (p≤0.05) and vice versa according to the Duncan's test. Stage
1: Workers in mechanical workshop; Stage 2: Workers in material milling; Stage 3: Workers in ovens; Stage 4: Workers in cement milling; Stage 5: Workers in packing. The sign (-) is mean an decrease, and The sign (+) is mean an increase.

Table (4) The effect of cement dust on the White Blood Cells count (WBCs) in the blood of workers in the production stages for new Badoosh Cement Factory and for different exposure periods.

| Variable | Exposure Period | Studies group | White Blood Cells Count WBCs (*10^9/l) |
|----------|-----------------|---------------|---------------------------------------|
|          | (4-10)Year | Mean±SE | % Count | Change % | Mean±SE | % Count | Change % | Mean±SE | % Count | Change % |
| Control  | 5. 89±0. 06 j | 100 | -- | 5. 89±0. 06 j | 100 | -- | 5. 89±0. 06 j | 100 | -- |
| Indirect exposure | 6. 28±0. 15 ij | 106 | +6 | 6. 48±0. 37 hi | 110 | +10 | 7. 24±0. 04 efg | 123 | +23 |
| Stage 1  | 6. 60±0. 17 hi | 112 | +12 | 7. 43±0. 12 def | 126 | +26 | 7. 90±0. 23 cd | 134 | +34 |
| Stage 2  | 7. 45±0. 21 def | 127 | +27 | 8. 32±0. 29 bc | 141 | +41 | 9. 45±0. 19 a | 160 | +60 |
| Direct exposure | 6. 89±0. 26 fgh | 117 | +17 | 7. 22±0. 13 efg | 123 | +23 | 7. 53±0. 13 de | 128 | +28 |
| Stage 3  | 7. 45±0. 21 def | 126 | +26 | 8. 49±0. 21 b | 144 | +44 | 9. 24±0. 07 a | 157 | +57 |
| Stage 4  | 6. 79±0. 13 ghi | 115 | +15 | 6. 91±0. 08 fgh | 117 | +17 | 8. 30±0. 35 bc | 141 | +41 |
**Table (5):** The effect of cement dust on the lymphocytes count of WBCs in of workers in the production stages for new Badoush Cement Factory and for different exposure periods.

| Variable Exposure Period | Lymphocytes (%) |
|--------------------------|------------------|
|                          | (4-10)Year       | (11-20)Year | (>20)Year |
| Control                  | 27.27±0.83       | 27.27±0.83  | 27.27±0.83 |
| D                        | 100              | 100         | 100        |

| Studies Group            | Indirect exposure | Direct exposure |
|--------------------------|--------------------|------------------|
| Stage 1                  | 28.10±0.32 D      | 33.20±0.68 C     |
| Administrators            | 103                | 122              |
| Stage 2                  | 38.07±1.48 B      | 38.07±1.48 B     |
| Stage 3                  | 29.40±0.69 D      | 35.70±1.04 bc    |
| Stage 4                  | 33.37±0.55 C      | 38.90±0.56 b     |
| Stage 5                  | 33.78±0.47 C      | 35.90±0.21 bc    |

*The numbers followed by vertically different letters indicate the presence of significant differences between them at the probability (p<0.05) and vice versa according to the Duncan's test. Stage 1: Workers in mechanical workshop; Stage 2: Workers in material milling; Stage 3: Workers in ovens; Stage 4: Workers in cement milling; Stage 5: Workers in packing. The sign (+) is mean an increase.*
Table (6): The effect of cement dust on the granules count of WBCs in of workers in the production stages for new Badoush Cement Factory and for different exposure periods.

| Variable | Exposure Period (4-10)Year | Granules(%) | Change % | Count | Mean±SE | Change % | Count | Mean±SE | Change % | Count | Mean±SE |
|----------|----------------------------|-------------|----------|-------|---------|----------|-------|---------|----------|-------|---------|
| Control  | Mean±SE 60. 27±4. f 28 | 100 --      |          |       |         |          |       |         |          |       |         |
| Studies | f                 | C-f          |          |       |         |          |       |         |          |       |         |
| Group    | Administrator       | 61. 23±2. 39 | 102 +2   | 64. 27±0. f 50 | 107 +7 | 66. 33±0. f 73 | 110+10 |
|          | Stage 1             | 62. 03±4. 17 | 103 +3   | 68. 50±1. a-e 96 | 114 +14 | 71. 07±0. a-d 48 | 118+18 |
|          | Stage 2             | 68. 70±1. 46 | 114 +14 | 72. 17±2. a-e 96 | 120 +20 | 75. 27±1. a 62 | 125+25 |
|          | Stage 3             | 60. 80±2. 26 | 101 +1   | 63. 73±0. a-e 52 | 106 +6 | 71. 77±1. a 62 | 119+19 |
|          | Stage 4             | 65. 53±2. 28 | 109 +9   | 67. 27±1. a-e 48 | 112 +12 | 74. 73±2. a 56 | 124+24 |
|          | Stage 5             | 65. 17±1. 12 | 108 +8   | 66. 03±1. a-e 48 | 110 +10 | 74. 90±2. a 56 | 124+24 |

*The numbers followed by vertically different letters indicate the presence of significant differences between them at the probability (p≤0.05) and vice versa according to the Duncan's test. Stage 1: Workers in mechanical workshop; Stage 2: Workers in material milling; Stage 3: Workers in ovens; Stage 4: Workers in cement milling; Stage 5: Workers in packing. The sign (+) is mean an increase.

4. Discussion

It is evident from the above that cement dust has a clear effect on the hematological variables, which led to a decrease in Hb concentration, PCV%, RBCs count and an increase in WBCs, lymphocytes and granules count in the blood of workers in the production stages for New Badoosh Cement factory for different exposure periods. The present findings of hematological variables are in agreement with the findings of several studies [11, 14, 12, 15, 16, 17, 5, 18, 19] for the workers in different locations, including cement factories, medicines factories and different professions and are exposed to different types of dust. These changes in the level of hematological variables of exposed workers are an indication of the effect of cement dust on the pathophysiology of blood and the reticule endothelial system of cement factory workers and in general human health [5]. Thus hematological function tests may be useful new variables in assessing and monitoring the health of cement factory workers in addition to the traditional lung function tests [12].

[18] also found a decrease in Hb concentration and RBCs count in subjects exposed to cement dust compared with control, as well as a negative correlation between blood components with exposure...
time, due to the chronic condition. Exposure to toxic substances from cement components silica crystals, calcium oxide and aluminum oxide, hexavalent chromium, are which cause inflammation and thus lead to decreased hemoglobin production.

The observed decrease Hb concentration, PCV%, RBCs count and increase WBCs, lymphocytes and granules count suggest that cement dust exposure may have a deleterious effect on the bone marrow, the source of these cells. The increase WBCs, lymphocytes and granules count probably suggests a reaction to irritant cement dust lodged in the lung [11, 12]. A high WBCs count is the primary value of a disordered immune response to white blood cells. And secondary response to certain toxins. WBCs count is often seen as a biomedical marker of inflammatory response [20].

[21] indicated that cement workers exposed to cement dust have decrease in RBCs count, which may due to responses of body to irritation [5], increase WBCs count which may be due to irritant cement dust particles deposited in the lungs, increase lymphocytes and granules count which are sign of stress response which lead to RBCs swelling or haemoconcentration plasma volume reduction [22] as a result of cement dust, a decrease in Hb concentration and PCV% which is a sign of anemic condition [23, 5].

5. Conclusion
We concluded from this study that exposure of workers in different productive stages and administrative unit to cement dust has caused clear negative effects on the blood components with an increase in the exposure period and a disrupted in metabolic and physiological processes. this may be attributed to the application of sanitary measures in terms of commitment to wearing a mask and avoiding dust for old workers.

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7. Reference
[1] Satarug S Garrett S Sens D and Sens M 2010 Cadmium environmental exposure and health outcomes Environ Heal Pers 118: 182-190.
[2] Al-Sultan AM and Jankeer MH 2020 The role of industrial pollutants on some antioxidants and lipid peroxidation for workers in different area of Mosul City Iraq Biochem Cell Arch 20(2):5797-5805.
[3] Al-Ahmady KK and cObeed HM 2015 Assessment of air particulate pollution in New Badoosh Cement Factory /Iraq Al-Raf Engin 23(3): 123-135.
[4] Al-Ani YM 2009 The investigation of allergy result from pollution in cement factory workers and measurement of the total IgE level Raf J Sci 20 (2):21-32.
[5] Emmanuel TF Ibiam UA Okaka AN and Alabi O 2015 Effects of cement dust on the hematological parameters in Obajana Cement Factory workers European Sci J 11(27):256-266.
[6] Rahmani AH Almatroud A Babiker AY Khan AA and Alsahly MA 2018 Effect of exposure to cement dust among the workers: An evaluation of health related complications Open Access Maced J Med Sci 233:1-4.
[7] Attri PK and Kalia S 2017 Study of environmental health status in Vicinity of A CC cement plant Barmana Bilaspur District (HP) Int J Agri Envir Res 3(10):8-23.
[8] Shanshal SA and Al-Qazaz HK 2020a Spirometric outcomes and oxidative stress among cement factory workers J Occup Envir Med 62(10):e581-e585.
[9] Osaro E Kebbe B Isaac I Nasiru A Marafa Y and Augustine N 2013 Effect of occupational exposure of cement dust on some haematological parameters of workers in a cement company in Sokoto Nigeria Int J Med Sci Heal Care 1(7):21-25.
[10] Shanshal SA and Al-Qazaz HK 2020b Knowledge and Practic of cement Factory Workers in relation to respiratory symptoms A cross-sectional study Sys Rev Pharm 11(6):864-870.

[11] Ewaid, S.H.; Abed, S.A.; Al-Ansari, N.; Salih, R.M. Development and Evaluation of a Water Quality Index for the Iraqi Rivers. Hydrology 2020, 7, 67.

[12] Jude CA Sasikalak AshokK R Sudha S and Raichel J 2002 Haematological and cytogenetic studies in workers occupationally exposed to cement dust Int J Hum Genet 2(2): 95-99.

[13] Mojiminiyi FB Merenu IA Ibrahim MT and Njoka CH 2008 The effect of cement dust exposure on haematological and liver function parameters of cement factory workers in Sokoto Nigerian J Phy Sci 23(1-2):111-114.

[14] Onkonkwo CO Ugwu CE Anakor AC Dike CC and Nwobodo E 2015 The effect of cement dust haematological Parameters of cementworkers in Asaba Delta State Nigeria J Envir Sci Toxi food Tech 9(1):105-108.

[15] Ahmed Alaa Kandoh et al 2021 IOP Conf. Ser.: Earth Environ. Sci. 790 012073.

[16] Barger A 2003 The complete blood cell count: a powerful diagnostic tool vet Clin Small Anim 33:1207-22.

[17] Salam Hussein Ewaid et al 2020 J. Phys.: Conf. Ser. 1664 012143.

[18] Divya PS and Suja S 2012 The Effect of Cement Dust Exposure on Hematological and Cytogenetic Studies of Cement Worker Res J Pharma Bio Chem Sci 3(1):615-620.

[19] Al-Ali ET 2013 Effect of environmental pollutants on some Physiological and biochemical parameters in workers of pharmaceutical industry M Sc Thesis College of Science University of Mosul Iraq.

[20] Khaled SAS 2014 Assessment of oxidative stress haematological kidney and liver function parameters of Libyan Cement Factory workers J American Sci 10(5):58-64.

[21] Ahmad R and Akhter S 2018 Effect of exposure to cement dust on hemoglobin concentration and total count of RBC in cement factory workers J Bangladesh Soc Physiol 13(2):68-72.

[22] Salam Hussein Ewaid et al 2021 IOP Conf. Ser.: Earth Environ. Sci. 722 012008.

[23] Al-Sultan AM 2020 Study of the balance system between some oxidants and enzymatic and non-enzymatic antioxidants for people of different professions in Mosul city and one of its suburbs M Sc Thesis College of Science University of Mosul Iraq.

[24] Coates TD and Baehner RL 1991 Leukocytosis and leucopenia In: Hematology Basic principles and practice ed by Hoffman R Benz E J Shattil S J Furie B and Cohen H J First edition Churchill Livingstone New York :552.

[25] Salam Hussein Ewaid et al 2021 IOP Conf. Ser.: Earth Environ. Sci. 790 012075.

[26] Divya PS and Suja S 2002 The Effect of Cement Dust Exposure on Hematological and Cytogenetic Studies of Cement Worker Res J Pharma Bio Chem Sci 2(2):95-99.

[27] Wilson RW and Taylor E W 1993 The physiological responses of freshwater rainbow trout on Corhynchusmykiss during acutely lethal copper exposure J Comp Phys Bio 162:38-47.

[28] Calistus JAL Sasikala K R Ashok Kumar S Sudha and Raichel L 2002 Int J Hum Genet 2(2):95-99 No title of work.

[29] Ali A Alsudani et al 2019 J. Phys.: Conf. Ser. 1294 062099.

[30] Ghaidaa Raheem Lateef Al-Awsi et al 2019 J. Phys.: Conf. Ser. 1294 062077.

[31] Ali A Alsudani and Ghaidaa Raheem Lateef Al-Awsi, 2020. Biocontrol of Rhizoctonia solani (Kühn) and Fusarium solani (Marti) causing damping-off disease in tomato with Azotobacter chroococcum and Pseudomonas fluorescens. Pakistan Journal of Biological Sciences, 23: 1456-1461.
[32] Ghaidaa Raheem Lateef Al-Awsi et al 2021 *IOP Conf. Ser.: Earth Environ. Sci.* 790 012013.

[33] Ali, W., & R. Annon, M. (2020). Biological Effective of organic solvent extracts of Mirabilis jalapa Leaves in the Non-cumulative for mortality of Immature stages Culex quinquefasciatus Say (Diptera: Culicidae). Al-Qadisiyah Journal Of Pure Science, 25(1), Bio 1-6.

[34] Sami Abd ali, mohammed, Shaker Hussein, A., & mohammed hadi, H. (2020). Study The Current Density-Voltage (J-V) Characteristics of α-Fe2O3 Thin Film Prepared by Spray Pyrolysis Technique. Al-Qadisiyah Journal Of Pure Science, 25 (1), Phys 1-7.