# RESULTS

## Water analysis

### *a- Unpolluted area*

From the data recorded by water analysis in the unpolluted area; it is clear that the overall mean of iron, lead, cadmium, zinc, copper, nickel, and mercury concentrations (ppm) in the water source were 0.195, 0.015, 0.00, 0.00, 0.04, 0.00, 0.04 respectively (Table 1).

### *b- Agriculture polluted area*

Water analysis in the area of the agricultural pollution showed that at zone (1) (at the mouth of the agricultural discharge) the overall mean of iron, lead, cadmium, zinc, copper, nickel, and mercury concentration (ppm) in the water source were 1.95, 0.105, 0.03, 0.055, 0.00, 1.45, and 0.725 respectively (Table 1). While at zone (2) (300 m after downstream of agricultural discharge mouth) the overall mean of iron, lead, cadmium, zinc, copper, nickel, and mercury concentration (ppm) in the water source were 1.45, 0.065, 0.03, 0.055, 0.00, 0.85 and 0.68, respectively (Table 1). On the other hand, at zone (3) (1000 m of downstream of agricultural drainage mouth the overall mean of these metals were 1.40, 0.065, 0.02, 0.035, 0.00, 0.70 and 0.60, respectively (Table 1).

### *c- Industrial polluted area*

From the data recorded, it is clear that at zone (1) the overall mean of iron, lead, cadmium, zinc, copper, nickel, and mercury concentration (ppm) in the water source were 3.85, 0.475,0.185, 0.195, 0.3, 3.4 and 4.41 respectively (Table 1). By water analysis at zone (2) the overall mean of iron, lead, cadmium, zinc, copper, nickel and mercury concentration (ppm) in the water source were 2.44, 0.325, 0.11, 0.145, 0.255, 2.65 and 3.68 respectively. Finally, at zone (3), the overall mean of the same metals were 2.5, 0.17, 0.08, 0.03, 0.30, 2.22 and 2.79, respectively (Table 1).

**Concentration of iron in the three localities**

Table (2), Fig.(2) indicated that the mean ± SE concentration of iron in the examined water samples were 0.195 ± 0.05, 1.95 ± 0.028, 1.45 ± 0.033, 1.4 ± 0.066, 3.85 ± 0.434, 2.44 ± 0.237, 2.5 ± 0.066 in unpolluted area and agricultural & industrial polluted water samples at different zones (0, 300 and 1000m), respectively. Concerning iron concentration of unpolluted area was within the accepted permissible limit of WHO. While in both agricultural and industrial polluted water 100 % of samples exceeded the permissible limit at the same time the mean of ferric in Industrial polluted water was higher than in agricultural polluted water.

**Concentration of lead in the three localities**

Table (3), Fig. (3) indicated that the mean ± SE concentrations of lead in the examined water samples were 0.015 ± 0.007, 0.105 ± 0.010, 0.065 ± 0.003, 0.065 ± 0.003, 0.475 ± 0.016, 0.325 ± 0.013 and 0.17 ± 0.033 in unpolluted area, and in agricultural; industrial polluted water at different zone (0, 300 and 1000 m) for both, respectively.

Concerning lead concentrations of unpolluted water was within the accepted permissible limit of WHO, while in both industrial and agricultural polluted water 100% of samples exceeded the permissible limit. However, the mean lead concentration in industrial polluted water was higher at all zone than in agricultural polluted one.

**Table (1): The mean concentrations of some heavy metals in the different localities far from any pollution sources, agricultural and industrial discharge.**

| Localities | | Iron mg/L | Lead mg/L | Cadmium mg/L | Zinc mg/L | Copper mg/L | Nickel mg/L | Mercury mg/L |
|---|---|---|---|---|---|---|---|---|
| Unpolluted locality | | 0.195 | 0.015 | 0.00 | 0.00 | 0.04 | 0.00 | 0.04 |
| Agricultural locality | - 0 m | 1.95 | 0.105 | 0.03 | 0.055 | 0.00 | 1.45 | 0.725 |
| | -300 m | 1.45 | 0.065 | 0.03 | 0.055 | 0.00 | 0.85 | 0.68 |
| | -1000 m | 1.40 | 0.065 | 0.02 | 0.035 | 0.00 | 0.70 | 0.60 |
| Industrial locality | -0 m | 3.85 | 0.475 | 0.185 | 0.195 | 0.3 | 3.4 | 4.41 |
| | - 300 m | 2.44 | 0.325 | 0.11 | 0.145 | 0.255 | 2.65 | 3.68 |
| | -1000 m | 2.5 | 0.17 | 0.08 | 0.03 | 0.3 | 2.22 | 2.79 |

**Table (2): The average values (mg/L) of iron from different localities.**

| Localities | | Min. value | Max. value | Mean ± SE | Number of Samples exceeding permissible limit | Percentages |
|---|---|---|---|---|---|---|
| Unpolluted locality | | 0.12 | 0.27 | 0.195±0.050 | - | - |
| Agricultural locality | - 0 m | 1.9 | 2.01 | 1.95 ± 0.028 | 4 | 100% |
| | - 300 m | 1.4 | 1.5 | 1.45 ±0.033 | 4 | 100% |
| | -1000 m | 1.3 | 1.5 | 1.4 ± 0.066 | 4 | 100% |
| Industrial locality | - 0 m | 3.2 | 4.5 | 3.85 ± 0.434 | 4 | 100% |
| | - 300 m | 2.09 | 2.8 | 2.44 ± 0.237 | 4 | 100% |
| | -1000 m | 2.4 | 2.6 | 2.5± 0.066 | 4 | 100% |

**Table (3): The average values (mg/L) of lead from different localities.**

| Localities | | Min. value | Max. value | Mean ± SE | Number of Samples exceeding permissible limit | Percentages |
|---|---|---|---|---|---|---|
| Unpolluted locality | | 0.00 | 0.03 | 0.015±0.007 | - | - |
| Agricultural locality | - 0 m | 0.09 | 0.12 | 0.105± 0.010 | 4 | 100% |
| | - 300 m | 0.06 | 0.07 | 0.065±0.003 | 4 | 100% |
| | - 1000 m | 0.06 | 0.07 | 0.065±0.003 | 4 | 100% |
| Industrial locality | - 0 m | 0.45 | 0.50 | 0.475±0.016 | 4 | 100 % |
| | - 300 m | 0.30 | 0.35 | 0.325 ± 0.013 | 4 | 100% |
| | - 1000 m | 0.12 | 0.22 | 0.17±0.033 | 4 | 100% |

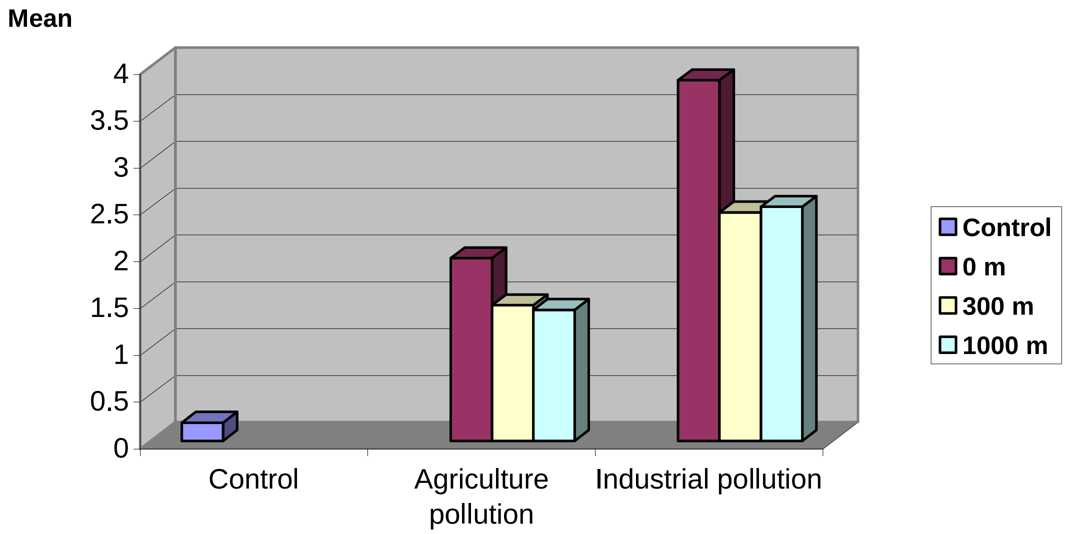


**Fig. (2): The average value of iron from different localities.**

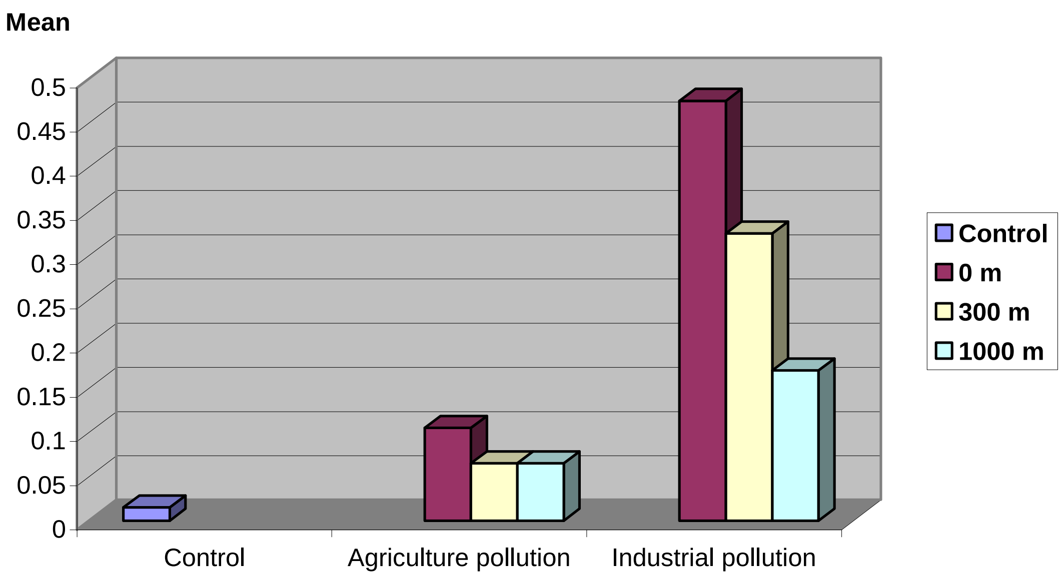


**Fig. (3): The average value of lead from different localities**

**Concentration of cadmium in the three localities**

Table (4), Fig. (4) indicated that the mean ± SE concentration of cadmium in the examined water samples were 0.00 in unpolluted area, 0.03 ± 0.006, 0.03 ± 0.006 and 0.02 ± 0.004 in agricultural polluted water, respectively and 0.185 ± 0.017, 0.11 ± 0.026 and 0.08 ± 0.006 in industrial polluted water, respectively.

The unpolluted sources was zero while in both agricultural and industrial polluted water 100% of water samples exceeded the permissible limit but the mean of cadmium concentration in industrial polluted water was higher than in agricultural polluted water at all distance.

**Concentrations of zinc in the three localities**

Table (5), Fig. (5) indicated that the mean ± SE concentrations of zinc of the examined water samples were 0.00; 0.055 ± 0.002, 0.055, 0.002, 0.035 ± 0.003, 0.195 ± 0.003, 0.145 ± 0.003 and 0.03 ± 0.006 in unpolluted water. Agricultural and industrial polluted water at different zone (0, 300 m and 1000 m), respectively.

All water samples were within the accepted permissible limit.

**Concentrations of copper in the three localities**

Table (6), Fig. (6) indicated that the mean ± SE concentrations of zinc in the examined water samples were 0.00, 0.04 ± 0.006, 0.00, 0.00, 0.00, 0.30 ± 0.133, 0.255 ± 0.023 and 0.3 ± 0.006 in unpolluted water and agricultural and industrial polluted water at different zone (0, 300 m and 1000 m) respectively.

Water samples were within the accepted permissible limit.

**Concentration of nickel in the three localities:**

Table (7), Fig. (7) indicated that the mean ± SE concentration of nickel in the examined water samples were 0.00, 1.45 ± 0.033, 0.85 ± 0.033, 0.70 ± 0.066, 3.4 ± 0.267, 2.65 ± 0.033 and 2.2 ± 0.066 in unpolluted area, agricultural and industrial polluted water at three zones (0, 300 and 1000 m) respectively.

Concerning nickel concentration of unpolluted water was zero, while in both industrial and agricultural polluted water samples exceeded the permissible limit by 100%. However, the mean nickel concentration in industrial pollution was higher than in agricultural pollution.

**Concentration of mercury in the three localities:**

Table (8), Fig. (8) indicated that the mean ± SE concentration of mercury in the examined water samples were 0.04 ± 0.008, 0.725 ± 0.01, 0.68 ± 0.006, 0.60 ± 0.02, 4.41 ± 0.167, 3.68 ± 0.177 and 2.79 ± 0.006 in unpolluted area, agricultural and industrial polluted water at different zones (0, 300 and 1000 m), respectively.

Unpolluted water was within the accepted permissible limit of WHO. While in both agricultural and industrial polluted water 100% of samples exceeded the permissible limit. The mean of mercury concentration in industrial polluted water samples was higher than agricultural polluted one.

**Table (4): The average values (mg/L) of cadmium from different localities.**

| Localities | | Min. value | Max. value | Mean ± SE | Number of Sample exceeding permissible limit | Percentages |
|---|---|---|---|---|---|---|
| Unpolluted locality | | 0.00 | 0.00 | - | - | - |
| Agricultural locality | - 0 m | 0.02 | 0.04 | 0.03±0.006 | 4 | 100% |
| | - 300 m | 0.02 | 0.04 | 0.03±0.006 | 4 | 100% |
| | - 1000 m | 0.01 | 0.03 | 0.02±0.004 | 4 | 100% |
| Industrial locality | - 0 m | 0.16 | 0.21 | 0.185 ± 0.017 | 4 | 100% |
| | - 300 m | 0.07 | 0.15 | 0.11± 0.026 | 4 | 100% |
| | - 1000 m | 0.07 | 0.09 | 0.08 ± 0.006 | 4 | 100% |

**Table (5): The average values (mg/L)of zinc from different localities.**

| Localities | | Min. value | Max. value | Mean ± SE | Number of Samples exceeding permissible limit | Percentages |
|---|---|---|---|---|---|---|
| Unpolluted locality | | 0.00 | 0.00 | - | - | - |
| Agricultural locality | - 0 m | 0.05 | 0.06 | 0.055±0.002 | - | - |
| | - 300 m | 0.05 | 0.06 | 0.055±0.002 | - | - |
| | -1000 m | 0.03 | 0.04 | 0.035±0.003 | - | - |
| Industrial locality | - 0 m | 0.19 | 0.20 | 0.195±0.003 | - | - |
| | - 300 m | 0.14 | 0.15 | 0.145±0.003 | - | - |
| | -1000 m | 0.02 | 0.04 | 0.03±0.006 | - | - |

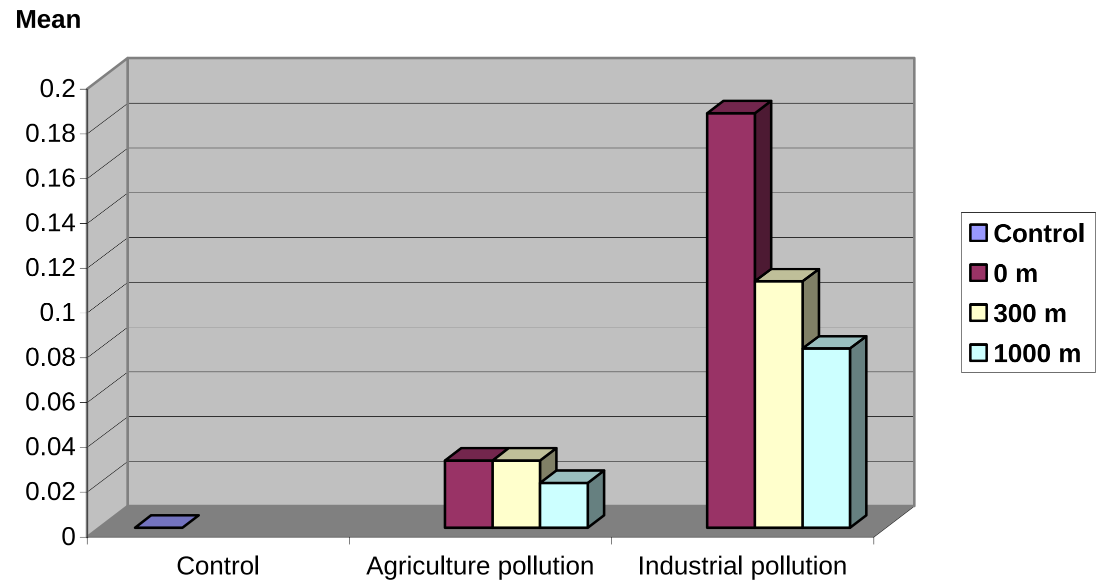


**Fig. (4): The average value of Cadmium from different localities**

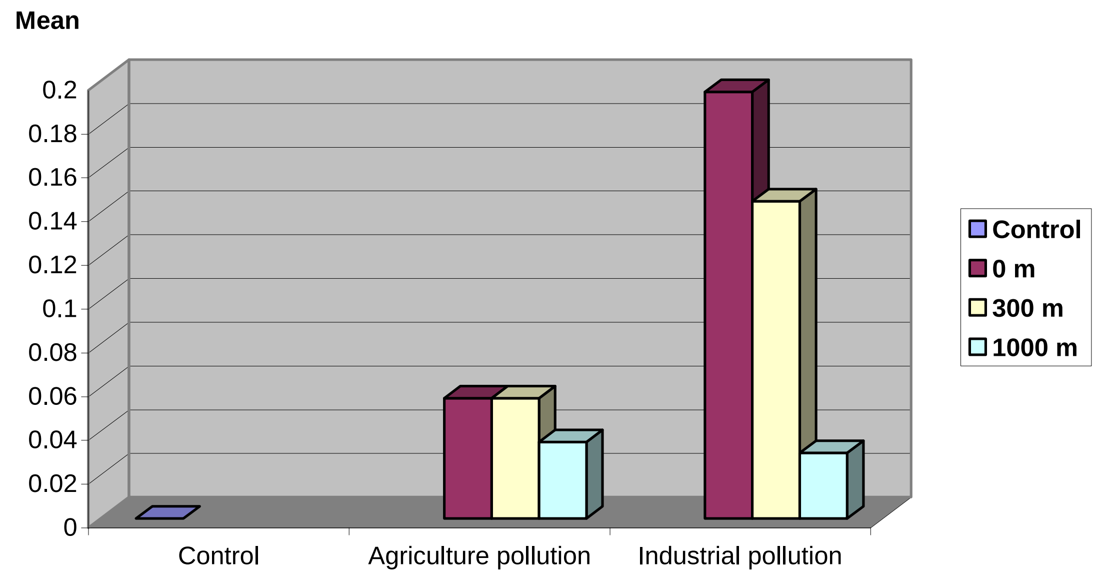


**Fig. (5): The average value of zinc from different localities**

**Table (6): The average values (mg/L) of copper from different localities.**

| Localities | | Min. value | Max. value | Mean ± SE | Number of Samples exceeding permissible limit | Percentages |
|---|---|---|---|---|---|---|
| Unpolluted locality | | 0.03 | 0.05 | 0.04±0.006 | - | - |
| Agricultural locality | - 0 m | 0.00 | 0.00 | - | - | - |
| | - 300 m | 0.00 | 0.00 | - | - | - |
| | -1000 m | 0.00 | 0.00 | - | - | - |
| Industrial locality | - 0 m | 0.1 | 0.5 | 0.3±0.133 | - | - |
| | - 300 m | 0.22 | 0.29 | 0.255±0.023 | - | - |
| | -1000 m | 0.29 | 0.31 | 0.3±0.006 | - | - |

**Table (7): The average values (mg/L) of nickel from different localities.**

| Localities | | Min. value | Max. value | Mean ± SE | Number of Samples exceeding permissible limit | Percentages |
|---|---|---|---|---|---|---|
| Unpolluted locality | | 0.00 | 0.00 | - | - | - |
| Agricultural locality | - 0 m | 1.4 | 1.5 | 1.45±0.033 | 4 | 100% |
| | - 300 m | 0.8 | 0.9 | 0.85±0.033 | 4 | 100% |
| | -1000 m | 0.6 | 0.8 | 0.70±0.066 | 4 | 100% |
| Industrial locality | - 0 m | 3.0 | 3.8 | 3.40±0.267 | 4 | 100% |
| | - 300 m | 2.6 | 2.7 | 2.65±0.033 | 4 | 100% |
| | -1000 m | 2.1 | 2.3 | 2.22±0.066 | 4 | 100% |

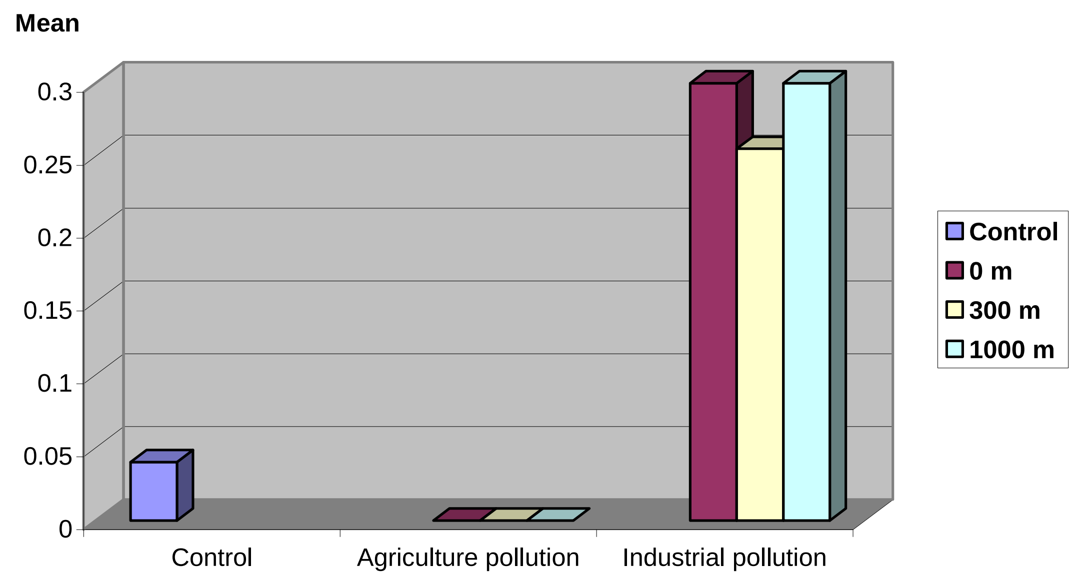


**Fig. (6): The average value of copper from different localities**

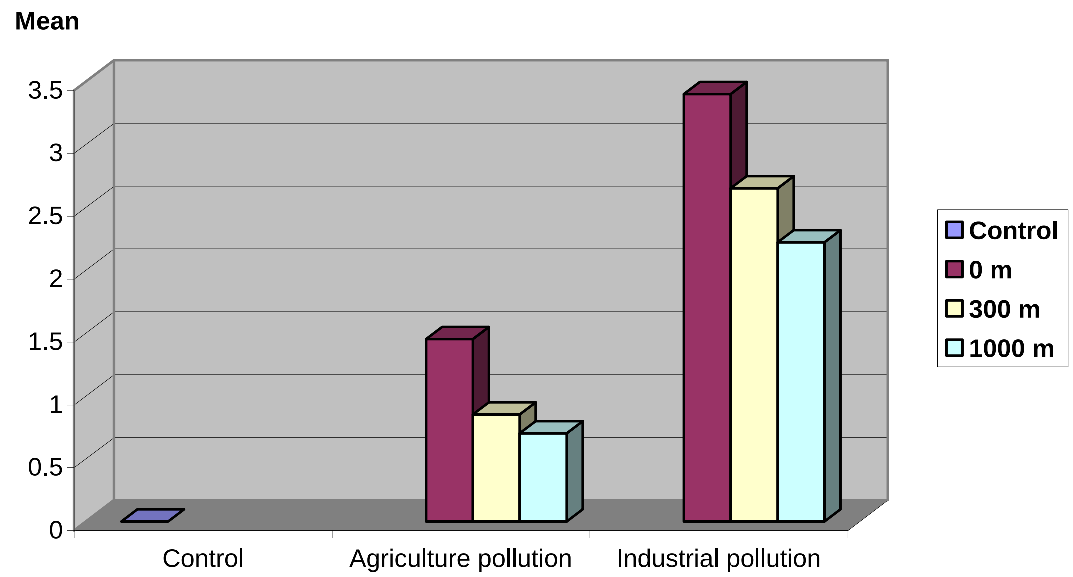


**Fig. (7): The average value of nickel from different localities**

**Table (8): The average values (mg/L) of mercury from different localities.**

| Localities | | Min. value | Max. value | Mean ± SE | Number of Samples exceeding permissible limit | Percentages |
|---|---|---|---|---|---|---|
| Unpolluted locality | | 0.03 | 0.05 | 0.04±0.008 | - | - |
| Agricultural locality | - 0 m | 0.71 | 0.74 | 0.725±0.01 | 4 | 100% |
| | - 300 m | 0.67 | 0.69 | 0.68±0.006 | 4 | 100% |
| | -1000 m | 0.57 | 0.63 | 0.60±0.02 | 4 | 100% |
| Industrial locality | - 0 m | 4.16 | 4.66 | 4.41±0.167 | 4 | 100% |
| | - 300 m | 3.42 | 3.95 | 3.68±0.177 | 4 | 100% |
| | -1000 m | 2.78 | 2.80 | 2.79±0.006 | 4 | 100% |

**Table (9): Recommended guidelines values (mg/L) of the examined metals in the water.**

| Metals examined | Recommended guide line values mg/L (ppm) |
|---|---|
| Cadmium | 0.010 |
| Lead | 0.050 |
| Mercury | 0.001 |
| Copper | 1.000 |
| Zinc | 5.000 |
| Nickel | 0.010 |
| Iron | 0.300 |

** WHO Guide lines values, who bulletin, guide lines for water quality Vol. 1, 1984.

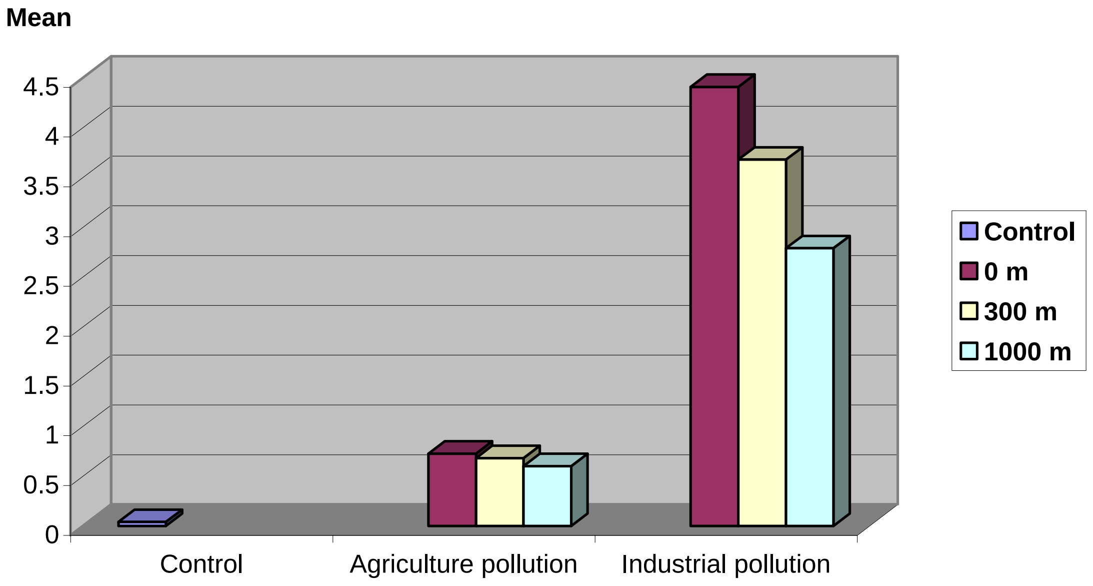


**Fig. (8): The average value of mercury from different localities**

## Cytogenetic investigations:

Various chromosomal aberrations were observed in head kidney cells of *Tilapia zilliii* collected from the different studied localities both industrial and agricultural. Both numerical and structural types of chromosomal aberrations were identified.

### I- Structural aberrations

These include centromeric attenuation Fig. (10), chromatid break Fig. (11), chromatid deletion (Fig.12), chromatid gaps Fig. (13), Fragmentation (Fig. 14), Ring (Fig.15) and end to end association (Fig. 16).

### II- Numerical aberrations

The stickiness is considered as a sort of chromosomal "agglutination" of unknown nature which results in a pycnotic or sticky appearance of chromosomes. Stickiness may give rise to sticky adhesions between two or more chromosomes and to formation of "sticky bridges" at anaphase, (Fig. 17). Also, the monosomy (Fig. 18) and polyploidy (Fig. 19) was found.

**Fig. (9):** Normal metaphase spread in head kidney cell of *Tilapia zillii* ((x 2000)).

**Fig. (10):** Metaphase spread of head kidney cells showing centromeric attenuation (x 2000).

**Fig. (11):** Metaphase spread of head kidney cells showing chromatid break (x 2000).

**Fig. (12):** Metaphase spread of head kidney cells showing chromatid deletion (x 2000).

**Fig. (13):** Metaphase spread of head kidney cells showing chromatid gap (x 2000).

**Fig. (14):** Metaphase spread of head kidney cells showing fragmentation (X 2000).

**Fig. (15):** Metahase spread of head kidney cells showing ring (x 2000).

**Fig. (16):** Metaphase spread of head kidney cells showing end to end association (x 2000).

**Fig. (17):** Metaphase spread of head kidney cells showing sticky (X 2000).

**Fig. (18):** Metaphase spread of head kidney cells showing monosomy (x 2000).

**Fig. (19):** Metaphase spread of head kidney cells showing polyploidy (x 2000).

**1- Centromeric attenuation**

The current study represented the average number of chromosomes having centromeric attenuation in head kidney cells of *Tilapia zillii* in polluted water. It is clear that, there is a very highly significant increase in the mean values between control fishes and fishes which were taken from industrial polluted water at zones (2 and 3) (300 m and 1000m). Also, there is significant increase in the mean value between fishes of control group and which were taken from agriculture polluted water at zone (1) only (Table10, Fig. 20).

**2- Break**

The number of chromosomes having chromatid break was also studied in the head kidney cells of *Tilapia zillii* in polluted water. The obtained results showed that there was a very highly significant increase of such chromosomes in the fish of industrial polluted area at all zones, when compared to the control one. On the other hand, the difference between the average values of control and agricultural polluted fishes at all zones was not significant (Table 11, Fig. 21).

**3- Deletion**

It is obvious that there was a very highly significant increase of deletion represented by head kidney cells, in the agricultural polluted fish than the control one, while at industrial polluted fish there was no significant difference between the average value of control and polluted fishes at all zones (Table 12, Fig. 22).

**Table 10**

**Fig. 20**

**Table 11**

**Fig. 21**

**Table 12**

**Fig. 22**

### 4- End to end association

End to end in head kidney cells of *Tilapia zillii* in polluted water elucidated a significant increase in the mean values of both industrial and agricultural pollution than control fish, with the exception of that at industrial pollution at zone (3). At the same time, in this type of aberration the higher values of abnormalities appear at agricultural polluted fish, followed by the industrial polluted one (Table 13, Fig. 23).

### 5- Chromatid Gap

Chromatid gap in the head kidney cells revealed a significant increase in the mean values of agricultural fish, at all zones (0, 300 and 1000 m). In case of the industrial pollution fishes a significant increase of gap was observed at zone (1) only (Table 14, Fig. 24)

### 6- Fragmentation

It’s apparent that there was a significant increase of fragmentation in the fish of both agricultural and industrial polluted area. The mean values of chromosomal aberration per 50 metaphase spreads were higher in polluted fish at all zones (0, 300 and 1000 m) (Table 15, Fig. 25).

**Table 13**

**Fig. 23**

**Table 14**

**Fig. 24**

**Table 15**

**Fig. 25**

**7- Ring:**

Head kidney cells of *Tilapia zillii* recorded that the number of chromosomes having ring should a significant increase in fish were taken from the industrial polluted water at all zones. In addition there was no significant difference between control fishes and agricultural polluted fishes at all zones, with the exception at zone (1) of agricultural polluted water which had a significant increase (Table 16, Fig. 26).

**8- Stickiness:**

Table (17), Fig. (27), symbolize the number of chromosome having stickiness in head kidney cells of *Tilapia zillii* in polluted water. The recorded mean values of stickiness of polluted fishes showed a significant increase at all distance (0, 300 and 100 m) for both industrial and agricultural polluted water over that of control values.

**9- Monosomy (2n-1):**

For monosomy aberration, it is apparent that the mean values of chromosomal aberration per 50-metaphase spread were higher in both industrial and agricultural pollution fishes than control ones. There was highly significant increase in polluted fishes at all zones for both industrial and agricultural pollution (Table18, Fig. 28).

**Table 16**

**Fig. 26**

**Table 17**

**Fig. 27**

**Table 18**

**Fig. 28**

**10- Polyploidy:**

Concerned to the polyploidy, it was cleared that at polluted water (agricultural and industrial) the mean values of chromosomal aberration was much higher than normal. There was very highly significant increase in polluted fishes at all zones for both agricultural and industrial pollution (Table 19, Fig. 29).

**Mitotic index**

It is evident that the mean values of the mitotic index of the polluted fishes (industrial and agricultural area) exhibited a significant decrease, than that of the control, at all zones of the exposure (Table 20, Fig. 30).

**Cells with one type of aberrations**

Table (21) and Fig. (31), illustrated the cells with one type of aberration in polluted fishes, it showed very highly significant level values at Agricultural and industrial pollution at all zones than normal.

**Cells with more than one type of aberrations:**

There is a significant increase in the mean values of cell with more than one type of aberrations in polluted fish over that of control at all zones (with the exception at zone (3) of agricultural polluted water the difference is non significance) (Table 22, Fig. 32).

Table (23), Fig. (33) depict the mean values of total structural aberrations in head kidney cells of *Tilapia zillii*. It is clear from the table that, the difference of average total structural aberrations in polluted water fishes, was very highly significant increase at all zones.

It transpired from the Table (24), Fig. (34) that the difference between the average values of the total numerical aberration in polluted water fish at all zones (0, 300 and 1000 m) and unpolluted one was very highly significant.

**Table 19**

Fig. 29

**Table 20**

Fig. 30

**Table 21**

Fig. 31

**Table 22**

Fig. 32

**Table 23**

**Fig. 33**

# Table 24

**Fig. 34**

**Table 25 without Fig.**

## DNA Fragmentation:

The recorded values of DNA fragmentation in agriculture polluted water fish showed a significant increase at zones (1 & 2). While at zone (3), DNA fragmentation was non significant when compared to control group (Table 26, Fig. 35). In case of industrial polluted area, it was apparent that their was a very highly significant increase of DNA fragmentation in polluted fish at all zones.

**Table (26) : The mean values of % DNA fragmentation in liver cells of *Tilapia zillii* in polluted water .**

| Pollution | | %DNA fragmentation | | T. test control & polluted | Anova |
|---|---|---|---|---|---|
| **Source** | **Distance** | **Mean** | **S.D** | | |
| **Control** | | 35.83 | 3.98 | | |
| **A g** | 1)0 m | 74.4 | 1.46 | 5.1** | 0.36 |
| | 2)300 m | 45.8 | 1.22 | 4.35** | |
| | 3)1000 m | 41.7 | 2.14 | 2.38 | |
| **In** | 1)0 m | 58.9 | 8.75 | 8.06*** | 0.92 |
| | 2)300 m | 67.47 | 3.71 | 7.53*** | |
| | 3)1000 m | 60.6 | 8.99 | 7.24*** | |

* Significant ($P \leq 0.05$)

** Highly significant 1 ($P \leq 0.01$).

*** Very highly significant ($P \leq 0.001$)

**Ag :** Agricultural pollution

**In :** Industrial pollution

**Fig. 35**

## Electrophoretic investigation

SDS polyacrylamide gel electrophoresis (PAGE) of proteins from liver of *Tilapia zillii* showed that the total number of polypeptides in the liver of unpolluted fishes (control) was 10 bands. The polypeptides were decreased to 7 and 8 bands in the liver of fishes taken from agricultural pollution at the three zones of (0, 300 and 1000 m), down-stream to the discharge mouth (Table 27, Figs. 36-39).

In control group, the most proteins presented in the liver had molecular weights of 114.47, 83.80, 57.63, 34.45, 27.14, 25.22, 21.27, 19.31, 15.49 and 12.76 (kDa). At zone (1) liver revealed 7 new synthesized polypeptides with molecular weight of 98.51, 71.56, 61.43, 38.83, 32.59, 22.97 and 18.00 kDa comparing to the control group. At zone (2), 6 new types of synthesized proteins were observed with molecular weights of 81.15, 62.92, 47.86, 38.17, 24.41 and 18.65 (kDa). On the other hand, at zone (3), the appeared, bands revealed 7 new synthesized polypeptides of molecular weight 85.05, 75.63, 68.21, 42.96, 23.12, 20.34 and 16.68.

In the current study, data of the electrophoretic pattern of proteins was also observed in the liver of fishes which were taken from the industrial pollution area at the three zones (Table 28, Figs. 40-42).

The total number of bands in the polluted fishes were 9, 9 and 8 respectively, prior to the three sites of fish collection. At zone one, 5 new synthesized polypeptide fractions appeared with molecular weight of 87.5, 47.8, 40, 30.03, and 16.80 kDa. These bands were not appeared in the unpolluted group. At zone (2), a different 6 bands of protein appeared with molecular weight of 84.02, 76.64, 54.14, 41.24, 30.13 and 16.56 kDa. By the exposure to zone (3), the appeared bands revealed 5 new polypeptides appeared rather than in control livers. It recorded molecular weights of 121.01, 100.94, 70.06, 45.94, and 17.11 kDa.

**Table (27): SDS-PAGE banding pattern of protein measured in liver of *Tilapia Zillii* from the area of Agricultural pollution.**

| M.wt kDa / Band No. | Protein Marker | Lane 1 Control | Lane 2 Zone (1) | Lane 3 Zone (2) | Lane 4 Zone (3) |
|---|---|---|---|---|---|
| 1 | | 114.47 | | | |
| 2 | 97 | | 98.51 | | |
| 3 | | | | | 85.05 |
| 4 | | 83.80 | | | |
| 5 | | | | 81.15 | |
| 6 | | | | | 75.63 |
| 7 | | | 71.56 | | |
| 8 | | | | | 68.21 |
| 9 | 66 | | | | |
| 10 | | | | 62.92 | |
| 11 | | | 61.43 | | |
| 12 | | 57.63 | | | |
| 13 | | | | 47.86 | |
| 14 | 45 | | | | |
| 15 | | | | | 42.96 |
| 16 | | | 38.83 | 38.17 | |
| 17 | | 34.45 | | | |
| 18 | | | 32.59 | | |
| 19 | 30 | | | | |
| 20 | | 27.14 | 27.23 | 27.01 | 27.86 |
| 21 | | 25.22 | | | |
| 22 | | | | 24.41 | |
| 23 | | | | | 23.12 |
| 24 | | | 22.97 | | |
| 25 | | 21.27 | | | |
| 26 | 20.27 | | | | 20.34 |
| 27 | | 19.31 | | | |
| 28 | | | 18.00 | 18.65 | |
| 29 | | | | | 16.68 |
| 30 | | 15.49 | | | |
| 31 | 14.20 | | | | |
| 32 | | 12.76 | | | |
| **No. of Fraction** | 6 | 10 | 8 | 7 | 8 |

**Zone (1):** 0 m at the mouth of the agricultural discharge
**Zone (2):** 300 m downstream of agricultural discharge mouth
**Zone (3):** 1000 m downstream of agricultural discharge mouth

**Table (28): SDS-PAGE banding pattern of protein measured in liver of *Tilapia Zillii* from the area of industrial pollution.**

| M.wt kDa / Band No. | Protein Marker | Lane 1 Control | Lane 2 Zone (1) | Lane 3 Zone (2) | Lane 4 Zone (3) |
|---|---|---|---|---|---|
| 1 | | | | | 121.01 |
| 2 | | 114.47 | | | |
| 3 | 97 | | | | 100.94 |
| 4 | | | 87.5 | | |
| 5 | | | | 84.02 | |
| 6 | | 83.80 | | | |
| 7 | | | | 76.64 | |
| 8 | | | | | 70.06 |
| 9 | 66 | | | | |
| 10 | | 57.63 | 57.5 | | |
| 11 | | | | 54.14 | |
| 12 | | | 47.8 | | |
| 13 | 45 | | | | 45.94 |
| 14 | | | | 41.24 | |
| 15 | | | 40 | | |
| 16 | | 34.45 | | | |
| 17 | 30 | | 30.03 | 30.13 | |
| 18 | | 27.14 | 27.8 | 27.00 | 27.75 |
| 19 | | 25.22 | 25.00 | | |
| 20 | | 21.27 | 21.46 | 21.46 | 21.52 |
| 21 | 20.10 | | | | |
| 22 | | 19.31 | | 19.00 | |
| 23 | | | | | 17.11 |
| 24 | | | 16.80 | 16.56 | |
| 25 | | 15.49 | | | 15.77 |
| 26 | 14.20 | | | | |
| 27 | | 12.760 | | | |
| **No. of Fraction** | 6 | 10 | 9 | 9 | 8 |

**Zone (1):** 0 m at the mouth of the industrial discharge
**Zone (2):** 300 m downstream of industrial discharge mouth
**Zone (3):** 1000 m downstream of industrial discharge mouth

Fig. Scanner (36)

Fig. Scanner (37)

Fig. Scanner (38)

Fig. Scanner (39)

Fig. Scanner (40)

Fig. Scanner (41)

Fig. Scanner (42)

This study was focused mainly on the polymorphic fractions in the different fish groups. According to this parameter, the fractions were classified as follow: absolute fractions, appeared in 100% of the tested individuals, constant fraction, appeared in 80 %, polymorphic fractions, present in a part of individuals less than 80% and 0 % that completely disappeared or absent fractions in all tested individuals.

Table (29), Fig. (43) represented the comparison of appearance frequency of liver proteinogram fractions between control group and agricultural pollution groups (at the different zones). From the data, it is revealed that, at zone (1) fractions number 1, 7, 9 and 10 completely disappeared, while, the polymorphism was exhibited in fractions number 2 and 6 with appearance of 20%, and fraction 3 with appearance 40%. Fraction 5 represented the constant appearance (80 %). On the other hand, at zone (2) there are 5 fractions (number 1, 3, 4, 6 and 10) completely disappeared, but the fractions Number 2, 5, 7, 8 and 9 showed polymorphism. However, fraction 2 showed constant appearance, at zone (3), the percentage of appearance frequency was 100% (absolute) for fractions number 5 but fractions number 1, 7, 9 and 10 completely disappeared, and polymorphic bands were 3, 4, 6 and 8 while the constant appearance was revealed by fraction 2.

The comparison of appearance frequency of liver proteinogram fractions between control group and industrial pollution groups (at the different zones). It is apparent that, zone (1), fractions number 1, 2, 4, 8 and 10 completely disappeared, also the polymorphism was observed in fractions number 6 (20%), 7 (60%) and 9 (40%) appearance, while fraction numbers showed constant appearance (80 %) (Table 30, Fig. 44) . At zone (2), the percentage of appearance frequency of this distance indicated that there was only fraction numbers 8 showed constant appearance, also polymorphism was exhibited in 7 fractions number 2,7 (60% appearance), 3, 4, 9 (40% appearance), 10 (10% appearance). The fraction number 5 was 100% appearance (absolute). However at zone (3), the percentage of appearance frequency of this group showed polymorphism in 3 fraction number 3 (60%), 4 (40%) and 7 (20%). At the same time fraction numbers 5, 8 showed constant appearance (80%). The same zone revealed also 4 fractions (1, 2, 6 and 10) were completely disappeared. It was also found that fraction number 9 showed absolute appearance (100%).

**Table (29): The frequency of appearance of liver proteinogram fractions in the control and agricultural polluted fishes at different distances.**

| Band No. | Control fractions (M.wt.) | Zone (1) | | Zone (2) | | Zone (3) | |
|---|---|---|---|---|---|---|---|
| | | Frequency | | Frequency | | Frequency | |
| | | Number | % | Number | % | Number | % |
| 1 | 114.47 | 0 | 0 % | 0 | 0% | 0 | 0 |
| 2 | 83.80 | 1 | 20% | 4 | 80% | 4 | 80% |
| 3 | 57.63 | 2 | 40% | 0 | 0% | 2 | 40% |
| 4 | 34.45 | 4 | 80% | 0 | 0% | 3 | 60% |
| 5 | 27.14 | 5 | 100% | 3 | 60 % | 5 | 100% |
| 6 | 25.22 | 1 | 20% | 0 | 0 % | 1 | 20% |
| 7 | 21.27 | 0 | 0% | 2 | 40% | 0 | 0% |
| 8 | 19.31 | 5 | 100% | 3 | 60% | 1 | 20% |
| 9 | 15.49 | 0 | 0% | 3 | 60% | 0 | 0% |
| 10 | 12.78 | 0 | 0% | 0 | 0% | 0 | 0% |

**Zone (1):** 0 m at the mouth of the agricultural discharge
**Zone (2):** 300 m downstream of agricultural discharge mouth
**Zone (3):** 1000 m downstream of agricultural discharge mouth

Fig. (43): Agricultural

**Table (30): The frequency of appearance of liver proteinogram fractions in the control and industrial polluted fishes at different distances.**

| Band No. | Control fractions (M.wt.) | Zone (1) | | Zone (2) | | Zone (3) | |
|---|---|---|---|---|---|---|---|
| | | Frequency | | Frequency | | Frequency | |
| | | Number | % | Number | % | Number | % |
| 1 | 114.47 | 0 | 0% | 0 | 0% | 0 | 0% |
| 2 | 83.80 | 0 | 0% | 3 | 60% | 0 | 0% |
| 3 | 57.63 | 4 | 80% | 2 | 40% | 3 | 60% |
| 4 | 34.45 | 0 | 0% | 2 | 40% | 3 | 40% |
| 5 | 27.14 | 4 | 80% | 5 | 100% | 4 | 80% |
| 6 | 25.22 | 1 | 20% | 0 | 0% | 0 | 0% |
| 7 | 21.27 | 3 | 60% | 3 | 60% | 1 | 20% |
| 8 | 19.31 | 0 | 0% | 4 | 80% | 4 | 80% |
| 9 | 15.49 | 2 | 40% | 2 | 40% | 5 | 100% |
| 10 | 12.78 | 0 | 0% | 1 | 10% | 0 | 0% |

**Zone (1):** 0 m at the mouth of the industrial discharge
**Zone (2):** 300 m downstream of industrial discharge mouth
**Zone (3):** 1000 m downstream of industrial discharge mouth

Fig. (44): Industrial