CHEMICAL EVALUATION OF POULTRY DRINKING WATER AT SHARKIA GOVERNORATE

Abd-El-Kader M.A.,* Abd-Elall A.M.M.,* Marzouk M. A. ** and Amira S. Atia*


ABSTRACT

This study was conducted to evaluate the chemical constituents of poultry drinking water from main water supplies and drinkers of broiler and layer poultry farms at Sharkia Governorate. For this purpose, a total of 100 water samples comprising 49 main water supply samples and 51 drinker's water samples were collected from 24 broiler farms and 25 layer farms located at different regions of Sharkia Governorate. The collected samples were examined chemically for determination of PH, ammonia, nitrite, nitrate, chloride, sulphate, total hardness, lead and cadmium concentrations. The results revealed estimation of the corresponding elements in main water supplies with the following mean concentrations: PH (7.32±0.04), ammonia (0.14±0.02 mg/L), nitrite (0.03±0.005 mg/L), nitrate (5.09±0.52mg/L), chloride (113.35±8.22 mg/L), sulphate (98.1±14.36 mg/L), total hardness (112.86±6.27mg/L), Lead (0.27±0.037 mg/L) and cadmium (0.0004±0.0001 mg/L). Whereas, the mean values of these elements in water of drinkers were 7.16±0.14, 0.65±0.07 mg/L, 0.12±0.01 mg/L, 24.50±2.14 mg/L, 193.1±10.22mg/L, 200.58±31.88 mg/L, 420.11±31.39 mg/L, 0.34±0.0396 mg/L, and 0.005±0.004 mg/L, respectively. Comparing the values of such chemical elements in main water supplies and drinker's water clarified higher significant values of most parameters in water of drinkers and this reflect the vital role of birds in water contamination. Moreover, investigation of examined water samples in relation to its source revealed higher nitrite, nitrate, chloride and total hardness in ground water than treated surface one. On contrast, treated surface water showed higher PH, ammonia, sulphate, lead and cadmium than ground water samples. In addition, water from drinkers of broilers had higher concentration of all chemical parameters than the water from drinkers of layers. The influence of determined chemical elements on poultry & public health and hygienic measures to protect poultry drinking water from contamination were fully discussed.
INTRODUCTION:

Water is a vital nutrient, involved in many aspects of poultry metabolism. It plays an important role in digestion, absorption of food, transportation of nutrients and elimination of waste products. So, raising poultry of high market value requires the availability of sufficient high quality water supplies. Water represents between 55-75% of the weight of a chicken and 65% of the egg, about 70% inside the cells and 30% is in fluid surrounding the cells and in blood. Consequently, water considered suitable for poultry should fulfill the requirements for human consumption (Robert and Swick 1998).

Drinking water is derived from two basic sources: surface waters and ground water. Therefore, quality of drinking water is strongly influenced by the quality of the corresponding "parent" natural water from which drinking water derives (Tsagarakis et al. 2003). All water contains natural contaminants particularly inorganics that arise from the geological strata through which the water flows and to a varying extent anthropogenic pollution by chemicals (Fawell and Nieuwenhuijsen 2003).

Poultry farms may use water from municipal sources (potable for humans), wells, streams, ponds and springs. Because of its nature of potential hydrogen bonding, water is an excellent solvent for both organic and inorganic substances and for this reason; water is an ideal medium for the proliferation and distribution of harmful components such as chemical elements. Water of low quality may affect layer production performance which indicated by decreased egg production and egg quality. Moreover, may depress water consumption (Koelkebeck et al. 1999). On the other hand, in broiler inferior quality water has detrimental effects on broiler performance and negatively correlated with body weight as well as immune resistance (Barton et al., 1986 and Grizzle et al. 1997).

Heavy metals may be primary in ground waters or leached from geologic formations, while in surface water may be run-off from land application, dumped from domestic and industrial sewage, atmospheric deposition of mining practices, smelter operations, improper handling of mining tailings, or as result of corrosion of distribution system materials (Calderon, 2000). In broiler and layers, there was a linear relationship between increasing concentration of lead in drinking water and some detrimental effects as decreasing water consumption, body weight, egg production, egg weight and increasing the percentage of embryonic mortalities (Vodela et al. 1997).
On the other hand, exposure of poultry to cadmium usually results in decrease in body weight (Bokori et al. 1996) and histopathological changes in different chicken tissues (Hassan, 1998).

At Sharkia Governorate, there is lack of information about the chemical contents of poultry drinking water. Therefore, this study was undertaken to determine the chemical elements of main water supplies and drinkers in broiler and layer farms through estimation of PH value, ammonia, nitrites, nitrates, chlorides, sulphates, total hardness and heavy metals (Lead and Cadmium).

Moreover, the frequency distribution of these chemical elements in relation to water source and type of production was investigated.

**MATERIALS & METHODS:**

**I-Sampling:**

A total of 100 water samples comprising 49 main water supply samples and 51 drinker's water samples were collected from 24 broiler farms and 25 layer farms located at different regions of Sharkia Governorate. Distribution of examined poultry farms and collected water samples was described in Table (1).

Generally, all the investigated broiler and layer farms were of deep litter system with one or two floor. Each floor consists of one or two pens, each pen considered as one house. All farms were climatic, naturally ventilated by means of hopper type windows and was provided with electrical fans to be used in hot weather. Moreover, all houses have smooth cemented walls and concrete roofs without any additional insulation.
Table (1): Distribution of examined poultry farms and collected water samples from different regions of Sharkia Governorate.

<table>
<thead>
<tr>
<th>Region</th>
<th>Broiler farms</th>
<th>Layer farms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of examined farms</td>
<td>No. of samples in relation to source</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Treated Surface water</td>
</tr>
<tr>
<td>1. Zagazig</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>2. Minia El-Kamh</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>3. Belbes</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>4. Hyhia</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5. Abo –Kaber</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>6. Fakose</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>7. Awlad Sakr</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8. Kafer Sakr</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>9. San El-Hager</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>10. Diarb Nigm</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>11. Abo –Hamad</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>24</strong></td>
<td><strong>26</strong></td>
</tr>
</tbody>
</table>

Watering of birds inside the farm was usually done from plastic bell-shape drinkers which consist from two parts; the water container which is filled with water then inverted over plastic plate having elevated edge, 5cm height. The water container provided with a hole at 3cm height from its edge to allow free moving of water into the plate. The drinker's capacity ranged from 5-10 liters, for young birds up to 5 weeks age, 5 liter capacity drinkers is enough for 50-100 birds, whereas for older ages, 10 litter capacity drinkers is used for 30-50 chicks.

The water samples were collected separately in clean, dry, one litter capacity; screw capped plastic bottles. Furthermore, for heavy metals examination, the bottles were cleaned by soaking in 10%HNO₃ for 48 hours, then were soaked in deionized water for a few minutes and finally rinsed three times with doubly distilled deionized water (Laxen and Harrison, 1981).

The technique of water sampling from main water supply was carried out according to HACH (2003).
Water was first allowed to run for several minutes to collect a representative fresh water sample then the container was rinsed several times with the water that to be sampled before collection. In case of lead examination, the first amount of water was collected. The sampling procedures from water of drinkers (bell-shape drinkers) were carried out by using sterile plastic syringes to obtain the required amount of water sample (one liter) from drinkers.

Each sample was labelled and identified showing its source, site, type of watering system and date of sampling. All the collected samples were transferred to the laboratory without delay (not more than two hours).

II- Chemical Examination:
All chemical examinations of collected water samples were done in the laboratory of Vet. Public Health Department and Central Laboratory of Faculty of Vet Medicine, Zagazig University as following:

(1) Reaction (PH value):
The PH value was determined by using digital PH meter (Accumet 395, USA).

(2) Ammonia (NH3):
Ammonia concentration in examined water samples was determined by using "The Direct Nesslerization Method" previously described by APHA (1985).

(3) Nitrite (No2):
Level of nitrite in the examined water sample was estimated by "Diazoitization Method" recommended by APHA (1998).

(4) Nitrate (NO3):
Concentration of nitrates in the examined water sample was determined by "Brucine Method" according to APHA (1960).

(5) Chlorides (Cl2):
Chlorides in examined water sample were estimated by "Argentometric method" described by APHA (1998).

(6) Sulphates (SO4):
Sulphates concentration was determined by "The gravimetric methods with ignition of residues" according to APHA (1998).

(7) Total hardness:
Total hardness of water sample was estimated by using "EDTA titrimetric method" as recommended by APHA (1998).

(8) Heavy metals:

a- Preparation of water samples:
Preparation of examined water samples was carried out according to APHA (1985) where the water sample was filtered through 0.45 µ whatman filter. The required volume (100 ml) of filtrate was collected in clean glass bottle, preserved by 0.3 ml of nitric acid and kept in refrigerator to avoid evaporation.

b- Atomic absorption spectrophotometer analysis:
Filtrated samples were analyzed for their heavy metal content by using BUCK Scientific Model 210 VGP atomic absorption spectrophotometer in Central Laboratory, Faculty of Vet. Medicine, Zagazig
University. Instrumental analysis of cadmium and lead was conducted by air acetylene lamp with wave length 228.9 and 283.2 nm for cadmium and lead, respectively. The concentration of cadmium and lead in the examined water samples were taken directly from digital seal reading of Atomic absorption spectrophotometer (WHO, 1996).

**III- Statistical analysis:** The collected data was analyzed using SPSS (2001).

**RESULTS**

Table (2): Chemical constituents of water samples collected from main water supplies and drinkers in all examined poultry farms.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Main water supply (N= 49)</th>
<th>Water of drinkers (N= 51)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>1-PH</td>
<td>6.8</td>
<td>7.86</td>
</tr>
<tr>
<td>2-Ammonia (mg/L)</td>
<td>*</td>
<td>0.73</td>
</tr>
<tr>
<td>3-Nitrite (mg/L)</td>
<td>*</td>
<td>0.148</td>
</tr>
<tr>
<td>4-Nitrate (mg/L)</td>
<td>*</td>
<td>9.75</td>
</tr>
<tr>
<td>5-Chloride (mg/L)</td>
<td>24.99</td>
<td>220.42</td>
</tr>
<tr>
<td>6-Sulphates (mg/L)</td>
<td>*</td>
<td>329.2</td>
</tr>
<tr>
<td>7-Total hardness as CaCO₃ (mg/L)</td>
<td>60</td>
<td>300</td>
</tr>
<tr>
<td>8-Lead (mg/L)</td>
<td>0.004</td>
<td>1.584</td>
</tr>
<tr>
<td>9-Cadmium (mg/L)</td>
<td>*</td>
<td>0.002</td>
</tr>
</tbody>
</table>
Table (3): Frequency distribution of chemical constituents of water samples collected from main water supplies & drinkers.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Maximum Acceptable level (MAL)</th>
<th>Main water supply (N=49)</th>
<th>Water of drinker (N=51)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Below MAL</td>
<td>Over MAL</td>
<td>Below MAL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>1-PH</td>
<td>6.8a</td>
<td>6</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>2-Ammonia (mg/L)</td>
<td>0.2b</td>
<td>4</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>3-Nitrite (mg/L)</td>
<td>0.2b</td>
<td>4</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>4-Nitrate (mg/L)</td>
<td>25c</td>
<td>4</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>5-Chloride (mg/L)</td>
<td>250c</td>
<td>4</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>6-Sulphates (mg/L)</td>
<td>250c</td>
<td>42</td>
<td>85.7</td>
<td>2</td>
</tr>
<tr>
<td>7-Total hardness (mg/L)</td>
<td>180c</td>
<td>4</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>8-Lead (mg/L)</td>
<td>0.02c</td>
<td>1</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>9-Cadmium (mg/L)</td>
<td>0.01c</td>
<td>1</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>


Table (4): Chemical constituents of water samples collected from main water supplies in all poultry farms in relation to its source.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Treated surface water (N=30)</th>
<th>Ground water (N=19)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± SE</td>
<td>Mean ± SE</td>
</tr>
<tr>
<td>1-PH</td>
<td>7.34 ± 0.06</td>
<td>7.28 ± 0.07</td>
</tr>
<tr>
<td>2-Ammonia (mg/L)</td>
<td>0.136 ± 0.03</td>
<td>0.134 ± 0.03</td>
</tr>
<tr>
<td>3-Nitrite (mg/L)</td>
<td>0.026 ± 0.005</td>
<td>0.031 ± 0.01</td>
</tr>
<tr>
<td>4-Nitrate (mg/L)</td>
<td>5.34 ± 0.69</td>
<td>5.98 ± 1.69</td>
</tr>
<tr>
<td>5-Chloride (mg/L)</td>
<td>107.83 ± 11.86</td>
<td>122.06 ± 9.97</td>
</tr>
<tr>
<td>6-Sulphates (mg/L)</td>
<td>101.53 ± 17.95</td>
<td>92.67 ± 24.42</td>
</tr>
<tr>
<td>7-Total hardness as CaCo₃ (mg/L)</td>
<td>110.2 ± 8.86</td>
<td>117.05 ± 8.29</td>
</tr>
<tr>
<td>8-Lead (mg/L)</td>
<td>0.299 ± 0.06</td>
<td>0.221 ± 0.04</td>
</tr>
<tr>
<td>9-Cadmium (mg/L)</td>
<td>0.0005 ± 0.0001</td>
<td>0.0005 ± 0.0001</td>
</tr>
</tbody>
</table>
Table (5): Chemical constituents of water samples collected from drinkers in relation to type of production.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Drinkers water of Broiler farms (N= 24) Mean ± SE</th>
<th>Drinker water of Layer farms (N= 27) Mean ± SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-PH</td>
<td>7.23 ± 0.22</td>
<td>7.09 ± 0.18</td>
</tr>
<tr>
<td>2-Ammonia (mg/L)</td>
<td>0.85 ± 0.11</td>
<td>0.46 ± 0.08</td>
</tr>
<tr>
<td>3-Nitrite (mg/L)</td>
<td>0.125 ± 0.02</td>
<td>0.109 ± 0.02</td>
</tr>
<tr>
<td>4-Nitrate (mg/L)</td>
<td>25.98 ± 3.02</td>
<td>23.18 ± 3.05</td>
</tr>
<tr>
<td>5-Chloride (mg/L)</td>
<td>204.12 ± 15.68</td>
<td>183.31 ± 13.36</td>
</tr>
<tr>
<td>6-Sulphates (mg/L)</td>
<td>204.24 ± 52.14</td>
<td>197.33 ± 39.41</td>
</tr>
<tr>
<td>7-Total hardness as CaCO₃ (mg/L)</td>
<td>444.81±49.53</td>
<td>398.15 ± 40.14</td>
</tr>
<tr>
<td>8-Lead (mg/L)</td>
<td>0.425 ± 0.07</td>
<td>0.261 ± 0.036</td>
</tr>
<tr>
<td>9-Cadmium (mg/L)</td>
<td>0.008±0.008</td>
<td>0.001 ± 0.0002</td>
</tr>
</tbody>
</table>

DISCUSSION:
1- Reaction (PH value):

The PH values of the main water supplies and water of drinkers in all examined poultry farms are shown in Table (2), it is clear that the mean PH values in main water supplies was 7.32 ± 0.04, meanwhile, in water of drinkers the mean PH values was 7.16 ± 0.04. These results are in agreement with those obtained by Chaidez et al. (2008), Shar et al. (2008) and Nikaeen et al (2009) and disagreed with those obtained by Haruna et al. (2005), Rim-Rukeh et al. (2007).

It is clear from Table (3) that all examined water samples (49 out of 49) from main water supplies and 88.2% (45 out of 51) of examined water of drinkers had PH below Maximum Acceptable Level (6-8) recommended by Muirhead, (1995). The remaining 6 (11.8 %) of examined water of drinkers had PH above recommended level.

Table (4) showed that the mean PH value in treated surface water was 7.34±0.06, whereas in ground water samples were 7.28±0.07. This clarified nearly similar PH values for both sources .On the other hand, results in Table (5), declared that the mean PH in water of drinkers at layer and broiler farms were 7.09 ± 0.18 and 7.23±0.22, respectively.

From aforementioned results, it clear that variations in PH values were higher in drinkers than main water supplies. Low pH values is due to high content of humic acids (Olajire and
Imeokparia, 2001) and carbon dioxide saturation in the ground water (Byam-ukama et al., 1999) or water which contains mineral acids (HCl, H2SO4 and HNO3). On contrast, high PH may be due to presence of high level of calcium and magnesium in water (Keshavarz, 1987). From public health point of view, Low PH value makes the water less palatable, corrodes metal parts of the watering systems and affect broiler performance and reduce shell quality (Keshavarz, 1987). However, alkaline water of more than 7.5 PH could damage equipments (Lack, 1988) and above 8.5 lead to mineral incrustation. (Samuel and Osman 1983).

2-Ammonia (NH3):

Ammonia concentrations in the examined water samples are shown in Table (2), it is obvious that in main water supplies, the mean value of ammonia was 0.14 ± 0.02 mg/L. These values were within the range that reported by Abd El-Hamid et al. (1992) and Ersoy et al. (2006). Higher ammonia concentrations were reported by Mohamed (2005) and Karavoltsos et al. (2008). Meanwhile, lower ammonia values were recorded by Fetouani et al. (2008). On the other hand, in water of drinkers, the mean value of ammonia was 0.65 ± 0.07 mg/L. These results are lower than that obtained by Moubarak (1989) who reported 3.87 mg/L as a mean value for ammonia in water of bell - shape drinkers.

Table (3) revealed that only 8 (16.3%) of main water supplies and 37 (72.5%) of examined drinkers having ammonia concentration above M.A.L. (0.2 mg/L) recommended by WHO (2006). These high levels of ammonia in water of drinkers could be postulated to deamination of organic nitrogen-containing compound in the form of feed particles and droppings mostly found in such an open type of drinkers (APHA, 1985).

Regarding ammonia concentration of examined water samples from main water supplies in relation to its source, Table (4) cleared that the mean value of ammonia in ground water was 0.134±0.03, whereas in treated surface water was 0.136 ± 0.03 mg/L. Ammonia is present naturally in surface water and with low levels in ground water because it adsorbs to soil particles and clays and not leached readily from soils (APHA, 1985). In addition, high ammonia concentrations in ground water are mainly found in regions of intensive agricultural activities, fertilizer run off and septic tank which discharge through the soil into ground water (Yang and Cheng, 2007).

Concerning ammonia concentration in examined water samples from
drinkers in relation to type of production, Table (5) clarified that ammonia concentration in drinkers of broiler farms (0.85±0.11 mg/L) is higher than ammonia concentration in drinkers of layer farms (0.46±0.08 mg/L). Such high concentration of ammonia constitutes an important indicator of recent sewage pollution and low level of hygiene (International Organization for Standardization, 1986), and cause odour and taste problems (WHO, 1996). Even more, it is detrimental to feed conversion and affected performance of commercial poultry flocks (Barton, 1996).

3-Nitrite (No2):

Nitrite concentrations in examined water samples collected from main water supplies and drinkers are presented in Table (2), it is obvious that the mean of nitrite was 0.03 ± 0.005 mg/L in main water supplies. These estimates are coinciding with those of Akoto and Adiyiah (2007) and Fetouani et al. (2008).

Whereas, higher nitrites concentrations were reported by Sobih et al. (1988) and Okafor and Ogbonna (2003). Lower nitrite levels were recorded by Ersoy et al. (2006). On the other aspect, in drinkers, the mean value of nitrite was 0.12±0.01 mg/L. These results were lower than those reported by Moubarak (1989) who recorded a mean value of 0.5 mg/L for nitrite in water of drinkers.

It is obvious from Table (3) that 9 (17.6%) of examined water from drinkers had nitrite above M.A.L. (0.2 mg/L), whereas all examined samples from main water supplies had nitrite below M.A.L. The significant higher nitrite in drinker's water reflect bad hygiene & frequent soiling of this type of drinkers with bird droppings, litter and feed particles as nitrite is an intermediate oxidation state of nitrogen, both by oxidation of ammonia & reduction of nitrate (APHA, 1985).

Table (4) showed that the mean value of nitrites in treated surface water was 0.026±0.005 mg/L, however, was 0.031±0.01 mg/L in ground water samples. These results substantiate what has been previously reported by Okafor and Ogbonna (2003) that ground water has more nitrite than in treated surface water.

The results present in Table (5) revealed nitrite concentration in drinker's water in relation to type of production, it could easily noticed that the mean nitrite value in drinkers of broiler was 0.125 ± 0.02 and this was higher than nitrite value in drinkers of layer (0.109 ± 0.02 mg/L). This may explained by higher motility and feeding activities of broiler birds with the subseq-
uent continuous pollution of drinker's water. On the other aspect, water of high nitrite concentration possesses a serious risk to poultry health as nitrite easily combined with hemoglobin of blood to form methemoglobin, which reduces blood ability to carry oxygen to different tissues ([USEPA, 1994]).

4- Nitrate (No₃):

Regarding nitrate concentration, it could easily noticed from Table (2) that in main water supplies, the mean value of nitrate was 5.09±0.52 mg/L, however in water of drinkers was 24.5±2.14 mg/L. The recorded nitrate values in main water supplies were within the range reported by Samaha (1985) and Ersoy et al. (2006). Higher nitrate concentrations were reported by Rim-Rukeh et al. (2007) and Fetouani et al. (2008). Meanwhile, Akoto and Adiyiah (2007) reported lower nitrate concentrations (from 0.09 to 0.99 mg/L) in examined drinking water in Ghana. On the other hand, our recorded nitrate concentrations in drinker's water were higher than that of Moubarak (1989) who detected 0.72 mg/L of nitrate in water of bell-shape drinkers.

Table (3) revealed that 47% (24 out of 51) of drinker's water had nitrate concentration above recommended level (25 mg/L) reported by Robert and Swick (1998), whereas all examined water samples from main water supplies had nitrate below recommended level. These increase in nitrate content of drinker's water usually resulted from oxidation of organic nitrogenous substances in water particularly ammonia & nitrite and reflects an old and prolonged contamination of drinkers ([APHA, 1985]).

Results recorded in Table (4) clarified that the mean values of nitrate were 5.34±0.69 and 5.98±1.69 mg/L in treated surface waters and ground water samples, respectively. These results are coincide with those recorded in south - eastern Nigeria, that ground water had higher nitrate concentrations than treated surface one ([Okafor and Ogbonna, 2003]). This may be explained by the high solubility of nitrate salts which don't bind to soils and migrate easily to ground water ([Papa, 2001]).

It is evident from Table (5) that the mean values of nitrate in water from drinkers of broilers (25.98±3.02 mg/l) was slightly higher than that in water from drinkers of layers (23.18±3.05 mg/L). Nitrate increase in commercial broiler water was negatively correlated with their body weight and depresses broiler performance ([Barton, 1996]) and was linked to methemoglobinemia through their reduction in blood to nitrite ([Robillard et al., 2003]).
5-Chlorides (CL\textsubscript{2}): 

Concerning chloride concentration, Table (2) pointed that in main water supplies the mean value of chlorides was 113.35±8.22 mg/L. Similar chloride estimates were previously reported by Mona (1987). Meanwhile, higher chloride concentration were also recorded (Hassan, 1993 and Christél et al., 2000). However, Haruna et al. (2005) and Wakawa et al. (2008) detected lower chloride estimates in examined water supplies. On the other hand, in water of drinkers the mean value of chlorides was 193.1±10.22 mg/L. These findings are lower than those of Moubarak (1989) who recorded a mean value of 742.1 mg/L for chloride in bell shape drinkers.

Table (3), declared that 17.6% (9out of 51) of drinkers water had chloride concentrations above M. A. L. (250 mg/L) suggested by Robert and Swick (1998), while all main supplies water had chloride below M. A. L. This increase in ch-loride levels of drinker's water is considered clear indication on water pollution and in the present circumstance, birds' droppings and feed particles appeared to be the source of pollution.

It could easily noticed from Table (4) that the mean value of chloride in treated surface water was 107.83±11.86, while was 122.06±9.79 mg/L in ground water sources. These finding are in complete agreement with those of Abbas et al. (2008), the author detected higher chloride in ground water than that in surface water.

Regarding chloride concentration in drinker's water in relation to type of production, Table (5) showed that the mean values of chlorides was 183.31±13.36 and 204.12±15.68 mg/L in drinkers of layer and broiler farms, respectively. This higher chlorides content in broiler drinkers could attributed to the high stocking density and frequent visiting of broilers to their drinkers in comparison to layer ones and this confirm the previously suggestion of poor sanitation in such broiler farms. From the hygienic point of view, the harmful effect of chloride appeared to be dependant on the cation present (APHA, 1985). High chloride in drinking water of poultry causing wet dropping specially if combined with hard water and high sulphate value (Euribird, 1982).

Evenmore, reduce water consumption and water/feed consumption ratio in broilers (Abbas et al., 2008), whereas affect egg shell quality (Balnave, 1993) and reduce laying rate in layers (Yoselewitz et al., 1993).
6- Sulphates (SO₄):

Regarding, sulphate in water samples collected from main water supplies and drinkers in all examined farms, Table (2) showed that the mean value of sulphate was 98.1 ± 14.36 mg/L in main water supplies. While, in water of drinkers, the mean value of sulphate was 200.58 ± 31.88 mg/L. Higher sulphate were recorded by Dagne et al. (2005) and Abbas et al. (2008). Meanwhile, lower sulphate were recorded by Abu–Zeid (1988) and Wakawa et al. (2008).

Table (3) indicates that 7 (14.3%) of water samples from main water supplies and 16 (31.4%) of water samples from drinkers having sulphate above M.A.L. (250 mg/L) suggested by Robert and Swick (1998). The excess of sulphate in drinker's water might be expected from contamination of their water with birds' droppings and feed particles.

The results presented in Table (4) show that the mean value of sulphate in treated surface water and ground water samples were 101.53 ± 17.95 and 92.67 ± 24.42 mg/L, respectively. The higher concentration of sulphate recorded in treated surface water in this study may attribute to that water sources come in contact with particular rock strata and mineral deposits (mainly gypsum) (Beamonte et al., 2007).

It is evident from Table (5) that water of drinkers in broiler farms has higher sulphate concentration (204.24±52.14 mg/L) than water of drinkers in layer farms (197.3 ± 39.41 mg/L). This difference may attribute to water source, level of bird activity in relation to age as well as standard of drinkers hygiene. From the hygienic point of view, high sulphate contents in drinking water affect the aesthetic quality of water (WHO, 1984), reduce water/feed consumption ratio, consequently resulting in worse feed conversion ratio of broiler (Zimmermann et al., 1993) and have a laxative effect (Carter and Sneed, 1996).

7-Total hardness:

Total hardness level in main water supplies and water of drinkers are shown in Table (2), it is obvious that in main water supplies the mean value of total hardness was 112.8±6.27 mg/L. Nearly similar values were previously reported by Arabi et al. (1998). Higher total hardness were recorded by Tantawy (1994). However, Shaaban et al. (1993) recorded a lower total hardness (from 51.0 to 131.2 as CaCO₃ mg/L) in examined drinking water. On the other hand, in drinker's water the mean value of total hardness was 420.11±31.39 as CaCO₃ mg/L. Moubarak (1989) reported a lower mean
values (1121.5 mg/L) of total hardness in bell shape drinkers.

Results present in Table (3) clarified that 100% of examined drinkers' water and only 4% (2 out of 49) of main water supplies had total hardness above M.A.L. (180 mg/L) reported by Robert and Swick (1998). This great increase in total hardness of drinkers is considered additional evidence on heavy contamination of such type of poultry drinkers and draws attention to the need for frequent cleaning and disinfection.

Table (4) pointed out the level of total hardness in examined water samples in relation to its source. It is noticeable that the mean value of total hardness in treated surface water was 110.2±8.86 mg/l, however in ground water was 117.05±8.29 as CaCO₃ mg/L. On the other aspect, total hardness concentration in drinker's water in relation to type of production are shown in Table (5). It is clear that the mean value of total hardness in drinkers of broiler farms (444.81±49.53 mg/L) was higher than that recorded in drinkers of layer farms (398.15±40.14 as CaCO₃ mg/L). High hardness affects the aesthetic quality of water (WHO, 1984) and cause watery dropping and leg deformations in poultry flocks (Gardiner and Cherson 1981). Furthermore, it leads to scales and crystals formation in different sections of watering system, clogging of pipes and drinkers (Keshavarz, 1987).

8- Heavy metals [Lead (Pb) and cadmium (Cd)]:

Regarding heavy metal concentration in water samples from the examined farms, Table (2) showed that, in main water supplies, the mean value of Cd and Pb were 0.0004±0.0001 and 0.27±0.037 mg/L, respectively. Meanwhile, in water of drinkers, the mean value of Cd and Pb were 0.005±0.004 and 0.34±0.0396 mg/L, respectively.

The recorded lead concentration lies within the ranges recorded by Ahmed (2002) and Abulude et al. (2007). Higher Pb values were reported by Abd El-Kader et al. (1993), meanwhile, Karavoltsos et al. (2008) and Lasheen et al. (2008) recorded lower Pb concentrations in main water supplies. On the other hand, Cd values are nearly similar to those detected by Wyatt et al. (1998) and Lasheen et al. (2008). Higher Cd residues were found by Christel et al. (2000), Ahmed (2002). However, Gasana et al. (1997) and Ramos et al. (1999) recorded lower Cd concentrations in examined water.

Table (3) cleared that all examined main water supplies and 98% of drinker's water had Cd below
M.A.L (0.01 mg/L) described by Robert and Swick (1998). Whereas, 98% (48 out of 49) and 96.1% (49 out of 51) of water samples from main water supplies and drinkers, respectively had lead concentration above M.A.L (0.02 mg/L) recommended by Robert and Swick (1998).

Results recorded in Table (4) show that the mean values of Cd and Pb in ground water samples were 0.0005±0.0001 and 0.221±0.04 mg/L, respectively. While, the mean values of these metals in treated surface waters were 0.003±0.0001 and 0.299±0.06 mg/L, respectively. These results were agreed with those of Rim-Rukeh et al. (2007) which found that Pb level in surface water (0.01 to 0.17 mg/L) was higher than its level in well waters (0.001 to 0.01 mg/L). These metals reach water by seepage from surrounding soil, pit dumping and sanitary land fills (Goel, 1997). Moreover, agriculture soil may be rich in heavy metals as a result of using of fungicides, herbicides and fertilizers works (Goel, 1997). On the other hands, in urbane areas, the major source of Pb is combustion of leaded fuel (Soylak and Elci, 2000). Also, the water supply networks were constructed several decades ago, resulting in leaching of lead from the old pipes (Bryant, 2004).

It is clear from Table (5) that the mean values of Cd and Pb in broiler water samples (0.009±0.008 and 0.425±0.07 mg/L, respectively) were higher than those in layer water samples (0.001±0.0002 and 0.261±0.036 mg/L, respectively). Thus, drinking water of broiler and layer farms showed elevated concentration of Pb and this cause bioaccumulation in poultry meat and egg. Furthermore, hens exposed to water containing mixture of Cd and Pb showed a drop in reproductive function as indicated by decreasing egg production, egg weight, hatchability and increasing embryonic mortality. In addition, decreased water consumption and body weight were observed in broilers chickens provided with high concentration of this mixture (Vodela et al., 1997).

From this study, it can be concluded that examination of chemical constituents of poultry drinking water samples revealed high values of all elements in water of drinkers as compared to the main water supplies and this reflect the vital role of birds in water contamination. Moreover, ground water had nitrites, nitrates, chlorides and total hardness higher than treated surface water. On contrast, treated surface water had PH, ammonia, sulphates, lead and cadmium higher than ground water. In addition, water from broiler drinkers had higher concentration of all examined parameters than water from layer drinkers. To minimize chemical pollution of
poultry water, the following recommendation should be applied:

1. Main water supplies of poultry farms either from ground or surface water sources should be examined chemically to confirm its fitness for poultry before use.

2. Piped water should run for few minutes before its use to allow sufficient cleaning of distribution systems.

3. Sufficient and equally distribution of drinkers within poultry farms according to density and age of bird

4. Protection of poultry water from contamination by frequent cleaning and thorough disinfection of drinkers which should raised from ground or the use of automatic drinkers

5. Health education of owners and farm workers about the hazardous effect of polluted water on poultry production and their human consumers health.

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الملخص العربي

تقييم الحالة الكيميائية لمياه شرب الدواجن بمحافظة الشرقية

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** قسم الصحة العامة البيطرية – كلية الطب البيطري – جامعة الزقازيق
مما لا شك فيه أن الماء يعتبر من العناصر الضرورية بالنسبة لحياة الطيور وصحتها. بالإضافة إلى ذلك تعتبر المياه من الأساسيات الهامة لزمن الهاجمة لمزارع الدواجن حيث تستخدم في أشياء كثيرة مما قد يكون له تأثير مباشر أو غير مباشر على نتائج الدواجن لذا فقد كان من الضروري القيام بهذه الدراسة لتقييم الحالة الكيميائية للمياه المستخدمة في بعض مزارع الدواجن وتحديد مدى صلاحيتها ومطابقتها للمعايير القياسية لمياه الشرب.

لهذا الغرض تم تجميع عدد 100 عينة مياه (49 عينة من المصدر الرئيسي للمياة بالمزرعة وعدد 51 عينة من مياه السقايات الموجودة بالمزارع) من عدد 24 مزرعة بداري التسمين و5 مزرعة بياض منتشرة بالمناطق المختلفة بمحافظة الشرقية. وقد تم فحص العينات كيميائياً لتحديد تركيزات الأس الهيدروجيني، الأمونيا، النيتريت، النترات، الكلوريدات، الكبريتات، العسر الكلي، الرصاص والكادميوم. أُسفرت النتائج عن تحديد العناصر السابقة في مياة المصادر الرئيسية للمياة بمتوسطات التركيزات التالية: الأس الهيدروجيني (23.4 ± 1319 ميليجم / لتر)، الأمونيا (1309 ± 1314 ميليجم / لتر)، النيتريتات (1317 ± 13111 ميليجم / لتر)، النترات (1314 ± 1314 ميليجم / لتر)، الكلوريدات (0.31 ± 2344 ميليجم / لتر)، الكبريتات (4230 ± 14.36 ميليجم / لتر)، العسر الكلي (0.4321 ± 1342 ميليجم / لتر)، الرصاص (1342 ± 131.2 ميليجم / لتر) والكادميوم (131119 ± 131110 ميليجم / لتر). بينما كانت متوسطات القيم لهذه العناصر في مياة السقايات هي (230 ± 1309، 1311 ± 10.07 ميليجم / لتر، 1311 ± 71.1 ميليجم / لتر). 1312 ± 10.22 ميليجم / لتر، 1310 ± 10.1 ميليجم / لتر، 1310 ± 10.2 ميليجم / لتر، 1310 ± 10.2 ميليجم / لتر، 1310 ± 10.2 ميليجم / لتر، 1310 ± 10.2 ميليجم / لتر).

وبمقارنة قيم هذه العناصر في مياة المصادر الرئيسية والمياه السقيات انتشر ارتفاع قيم كل العناصر الكيميائية في مياة السقايات عنها في مياة المصادر الرئيسية مما يعكس الدور مهم للماء في تلوث الماء. علاوة على هذا اظهر الفحص الكيميائي للمياه مع الإشارة الى نوعية مصادر المياه للمزارع المختلفة احتراء مصادر المياه الجوفية على تركيزات مرتفعة من النيترات، النيترات، الكبريتات، والرصاص الكلي. كما هو متواجد في مياة المياه السطحية المعالجة. من ناحية أخرى فقد احتوت المياه السطحية المعالجة على تركيز أعلى لاستخدام الهيدروجيني والأمونيا في العديد من المصادر والعناصر الثقيلة من الرصاص.
والكادميوم. بالإضافة لهذا فقد احتوت مياه السقايات بمزارع بداري التسمين علي تركيزات مرتفعة لجميع العناصر السابقه عما هو متواجد بمياه السقايات بمزارع الدجاج البياض. وقد تم مناقشة تأثير زيادة هذة العناصر علي صحة وانتاج الدواجن وكذلك الاجراءات الصحية الازمه لحماية مياه شرب الدواجن من التلوث بهذه العناصر.