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(RESEARCH ARTICLE)

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Evaluation of bacteriological and chemical quality of drinking water used in chicken house in Libya

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Abstract

Water is a vital nutrient in poultry metabolism, which plays an important role in digestion, absorption of food, transportation of nutrients in the body and elimination of waste products via urine. The objective of this study was to investigate the physical, chemical and bacteriological parameters of water samples were collected from 35 broiler farms distributed in four districts (Qasar Bin Gheshir, Wadiarrabee, Zawia, and Zahra). In each farm, the samples were collected from the water source, the tank inside of chicken house and end of pipes. The samples were subjected to physical, chemical and microbial examination. The main investigated parameters were PH, total dissolved solid, Total Hardness, Calcium, Chloride, Nitrate, and total viable count of microbial load. Chemical analysis indicated that all chemical and physical parameters were higher than Maximum acceptable level, except TDS and magnesium in Qasr ben Gheshir and Wadi Al-Rabia regions, as well as PH in all regions. The bacteriological examination revealed that the coliform counts were 91% over the maximum acceptable level in all regions. Also, the results showed that significant difference between reservoir, tank and pipe with p value (<0.05) where the coliforms contamination in the pipe was more than in the tank and the reservoir. The results also showed that 50% of the samples were contamination with *E. coli*. Generally, the water collected from the different sources need more treatment to improve the drinking water quality especially for their microbial load.

Keywords: Water; Poultry; Physical; Chemical; Bacteriological; Coliform

1. Introduction

Water is one of the most important natural resources and essential in maintains human, plant and animal life in the world (6). It is a vital nutrient in poultry metabolism, which plays an important role in the digestion, absorption of food, transportation of nutrients in the body and elimination of waste products via urine (9). At normal temperatures, poultry consume water at least twice a day (7). Water represents 55% - 75% of the weight of a chicken and 65% of the egg. About 70% is inside the cells and 30% is in fluid surrounding the cells and in blood. As fat increases in the carcass with age, the percentage of total body water decreases. The poultry obtain water by drinking, eating and catabolism of fatty deposits and other body tissues. Water acts as a solvent for organic and inorganic nutrients. It is essential in metabolism and required for movement of feed through the digestive system. It is able to store a large amount of heat in liquid form and then loose heat upon evaporation. This is important in temperature regulation. Also, it is useful vehicle for flock medication. (10).

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Underground water supplies, often containing high concentrations of dissolved salts, are a common source of drinking water of poultry in many countries. Recent information suggests that some minerals in drinking water may cause adverse effects on the performance of growing broilers and layer. A large number of chemicals occur naturally in well water usually present in amounts that do not interfere with the metabolism or digestive functions of poultry. When the levels of certain chemicals are out of balance, they can by themselves or in combination with other chemicals affect poultry performance (4). Disease spreading through water can result in great losses to the producer, besides the hazards of carrying zoonosis pathogens to the herd, which would reflect in a Public Health problem. Diseases that can be transmitted to the bird flock though the drinking water may originate from water contamination by feces and secretions of sick birds, or by the utilization of water already contaminated by pathogenic organisms that originate from other animal species and the man, such as in the case of salmonella and *Escherichia coli*, respectively.

Quality of drinking water including physical, chemical and microbiological considers a fundamental importance in poultry industry.

Microorganism play important role in water contamination. The most common are bacteria, especially coliforms. Contaminated water with faecal coliforms severely affects the performance of poultry. The sources of water contamination for poultry are faeces and secretions of sick birds, animals and the human.*Salmonellae*, *Compylobacter spp.* and *Escherichia coli* are the main poultry pathogens responsible for water contamination. In addition to bacterial contamination, there are Physical, Chemical which affect on water quality e.g. too high or too low PH level, extreme hardness, high magnesium, high nitrates, high sodium, chloride and other minerals (10). Pesticides and other agricultural chemicals may also be influenced by water quality. Their efficacy may increase or decrease suspended solids, hardness, dissolved solids, bicarbonate, and pH are of most concern. The effectiveness of vaccines and medications administered through the water lines could be reduced when water quality is poor. (7)

The present study was conducted to investigate the bacteriological parameters and to determine the physical and chemical parameters that affects the quality of waters.

2. Material and methods

2.1. Sampling

From August to October 2010, water samples from 35 broiler farms distributed in four districts (Qasar Bin Gheshir, Wadiarrabee, Zawia, and Zahra) were investigated for coliform contamination. In each farm, the samples were collected from the water source, the tank inside of chicken house and end of pipes. The pipe water was sampled after being allowed to run for several minutes, and after flaming the outlet.

Water samples were collected after flaming the outlet and after allowing running for several minutes to remove the first water flushes. The drinking water was not treated with any disinfectants or antibiotics. Two samples of water were collected from the same source in clean and sterile bottles. Then closed and immediately transported to laboratory for chemical and bacteriological analysis.

2.2. Physical and chemical analysis

The physical and chemical contamination analyses were carried out according to the Standard methods (2).

2.2.1. pH value

The pH was measured by using digital pH meter with a glass electrode according to standard methods (Potentiometric EPA 600/4-79-02). Buffer solutions of pH 4.0 and 7.0 were prepared to adjust the pH meter.

2.2.2. Chemical analysis

Total dissolved solids (TDS)

The beaker was weighed empty (W1). 100 ml of the sample was filtered in the beaker.

The sample was put in the oven at 180 ºC, and then the sample put in Desiccators. After cooling the sample, the salts weighed with the beaker (W2).

The weight of the salts in 100ml of the sample W2-W1=W3

2.3. Total Hardness

Total hardness of water is defined as total of the calcium and magnesium salts concentration, expressed as calcium carbonate, measured by EDTA titrimetric method (ethylene diamine tetra acetic acid disodium salts) as described by standard methods (titrimetric, EPA 600/4-79-02).

2.3.1. Calcium

Calcium content in water was determined by using EDTA Titrimetric method according to standard methods (titrimetric,EPA 600/4-79-02). The indicator used was one that reacts with calcium only and gives a color change when all of the calcium has been complexes by EDTA at pH of 12 to 13 with addition of sodium hydroxide solution.

2.3.2. Chloride

It was determined in a neutral or slightly alkaline solution by titration with standard silver nitrate solution. Potassium chromate as indicator and standard Silver nitrate (titrimetric, EPA 600/4-79-02)

2.3.3. Nitrate

The water samples were analyzed by ultraviolet Spectrophotometer programmed adjusted to the wave length λ 400nm the result was reported as $NO3^-$ mg /L.

2.4. Bacteriological analysis

Enumeration of Coliform Bacteria the Most Probable Number (MPN) technique was used for enumeration of total coliforms and fecal coliforms according to standard methods (1). The multiple tubes fermentation method comprises three steps:

- Presumptive test
- Confirmed test
- Completed test

2.4.1. Presumptive test

The multiple tube fermentation technique was performed as presumptive test. Determination of the most probable number (MPN) coliform bacteria was carried out using tubes containing MacConkey broth and inverted Durham tubes. The inoculation was done in replicates of three. To each of 3 double strength MacConkey broth tubes 10ml of the original sample were added, also to each 3 single strength MacConkey broth tubes 1 ml of the original sample were added and then 0.1 ml of original sample were added to 3 single strength MacConkey broth tubes. All tubes were incubated at 37 ºC for 48 hours for the observation of gas production. First reading was taken after 24 hours to record positive tubes and the negative ones were incubated for another 24 hours.

2.4.2. Confirmed test

Each gas positive presumptive tube was inoculated into a tube containing brilliant green lactose bile broth (BGB) media at 37 ºC for 48 hours for the observation of gas production.

2.4.3. Completed test (fecal coliform test)

- At least 3 loopfuls of each confirmed positive tubes were inoculated into BGB media then incubated at 44 ºC for 24 hours. Tubes showing any amount of gas production were considered as positive and the most probable number (MPN) was recorded.
- At least 3 loopfuls of each confirmed positive tubes were inoculated into tryptone water then incubated at 44 ºC for 24 hours.

3. Results and discussion

Blake and Hess (2001), and Carter and Sneed (2007) considered that maximum Acceptable Level of coliforms in the drinking water of poultry should be 50 CFU /ml.

The results showed that the coliform counts in 35 farms in the four regions were 91% over the maximum acceptable level and 9% in the normal range (Table and figure1). There was no significant difference in coliform count between

regions with *p* value (0.201). This indicated that coliforms was detected in all regions and could be due to free access of wild and domestic animals to the water sources, disposal of animal excreta, and even the drainage of human's sewage. The present study was similar to the study achieved by Jafari, *et al* (2006). On the other hand, the results of analysis showed that significant difference between reservoir, tank and pipe with *p* value (0.05) where the coliforms contamination in the pipe was more than in the tank and the reservoir. This could be due to the lack of an effective cleaning and disinfectant, the lack of appropriate duration of treatment with disinfectant, and the period of time for contact disinfectants with internal surfaces of the tubes are not enough.

Table 1 MPN of coliform bacteria in water of poultry house

Farm	Zawia	Qasar Bin Gheshir	Zahra	Wadiarrabia
H 1	1100	1100	1100	240
H 2	3	240	290	1100
H 3	36	240	240	3
H 4	1100	460	1100	460
H 5	240	93	1100	1100
H 6	1100	1100	93	240
H 7	460	290	1100	290
H 8	460	240	290	-
H 9	290	-	1100	-
H 10	1100	-	-	-
H 11	1100	-	-	-

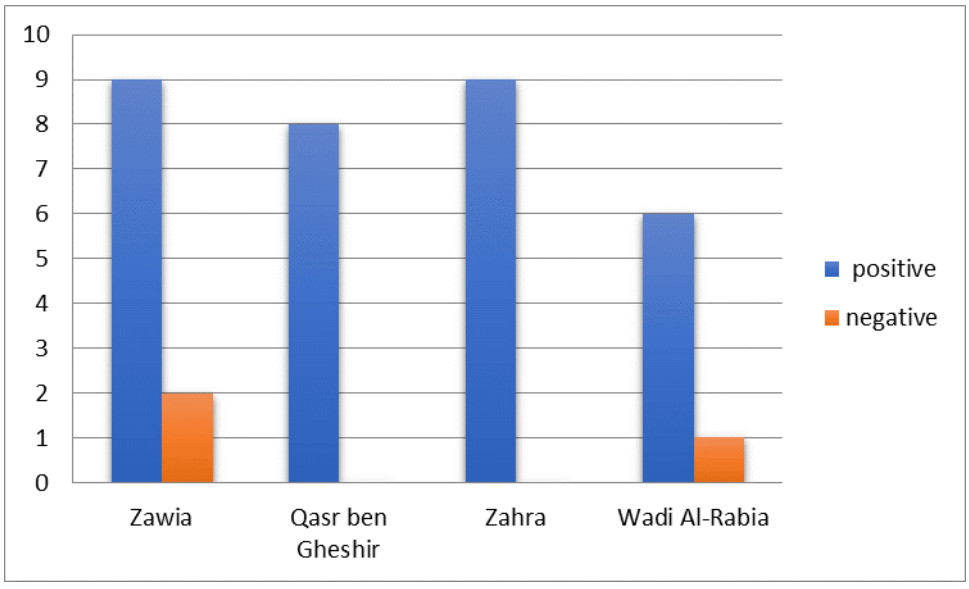

Figure 1 MPN of Coliforms Bacteria in different region

The positive samples with coliforms were inoculated into BGB media and tryptone water for detection of *E. coli.* The results showed that 50% of the samples were contamination with *E. coli,* while 50% of samples were negative. Significantly, there was difference between regions with *p* value (0.009). (Table and figure 2)

Table 2 Number and percentage of the farms affected with *E. coli*

Region	Number of positive	Percentage
Zawia	6	54.5%
Qasr ben Gheshir	4	37.5%
Zahra	2	22.2%
Wadi Al-Rabia	4	57.1%

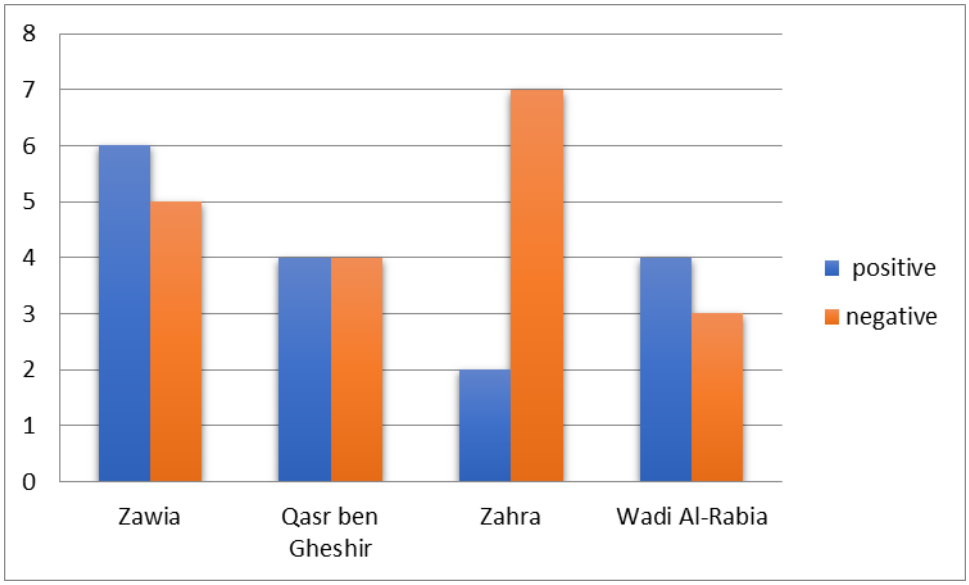

Figure 2 The farm contaminated with *E.coli*

The presence of *E.coli* in all regions could be due to free access of wild and domestic animals to the water sources, disposal of animal excreta, and even the drainage of human's sewage. Also, could be due to the lack of an effective cleaning and disinfectant, the lack of appropriate duration of treatment with disinfectant, and the period of time for contact disinfectants with internal surfaces of the tubes are not enough. Goan*et al.* (1992) examined water samples collected from 105 wells of 65 flocks in the United States, and reported that fecal coliforms were present in 43% of the samples.

In the chemical analysis, Blake and Hess (2001), and Carter and Sneed (2007) considered the normal range of chemical and physical factors as illustrated in table (3).

Table 3 Drinking Water Quality Standards for Poultry

Characteristic	Normal range
PH	6.8-7.5
TH	60-180
TDS	<1500
Calcium	60 mg/ l
Chloride	14-250 mg/ l
Magnesium	14-125 mg/ l
Nitrate	25 mg/ l

As shown in (the table 4 and figures 3, 4, 5) in chemical analysis, the present results demonstrated that all chemical and physical parameters were higher than Maximum acceptable level, except TDS and magnesium in Qasr ben Gheshir and Wadi Al-Rabia regions, as well as PH in all regions.

Table 4 Comparison physico-chemical parameters between regions

Region	PH	TDS	TH	Calcium	Magnesium	Chloride	Nitrate
Zawia	7.4	2524	1735	394	174.8	432.7	96
Qasr ben Gheshir	7.7	819	635	146	54.5	353.3	36.6
Zahra	7.5	2265	1353	314	138.3	430.4	50.3
Wadi Al-Rabia	7.3	1421	596	109	77.4	464.8	27.5

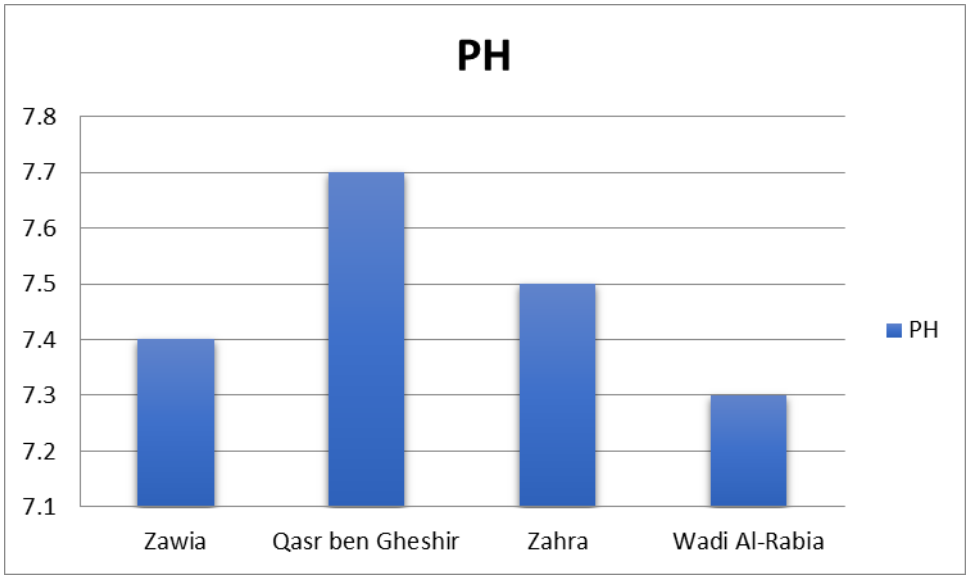

Figure 3 Comparison PH between regions

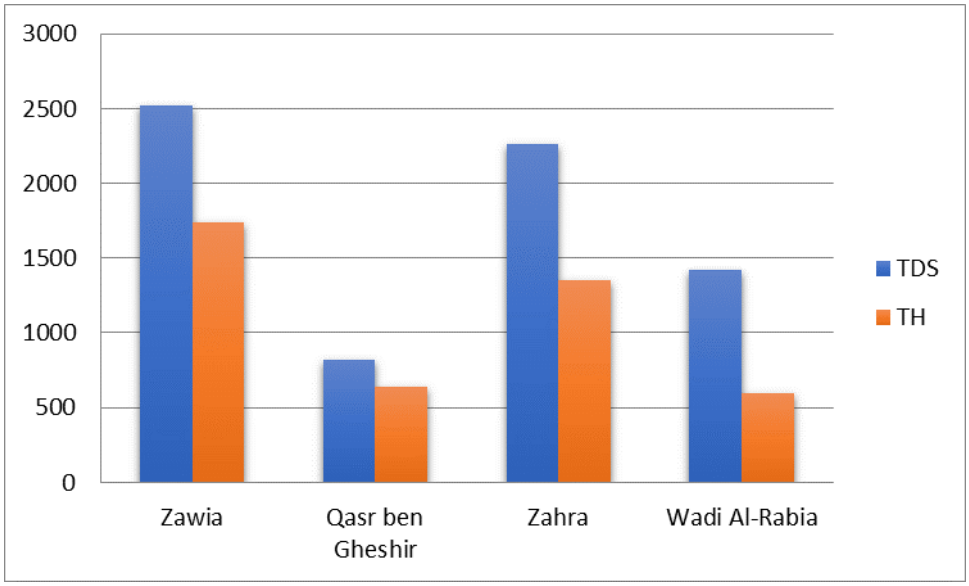

Figure 4 Comparison TDS and TH between regions

We found a significant difference between regions in the levels of TDS, TH calcium, magnesium and nitrate where the highest level of TDS was 2524 ppm in Zawia region, while the lowest level was 819 ppm in Qasr ben Gheshir. The highest level of TH was 1735 ppm in Zawia region, while the lowest level was 596 in Wadi Al-Rabia region. The highest level of calcium was 394 ppm in Zawia region, while, the lowest level was 596 in Wadi Al-Rabia region. The highest level of magnesium was 174.8 ppm in Zawia region, while the lowest level was 54.5 in Qasr ben Gheshir. The highest level of nitrate was 50.3 in Qasr ben Gheshir, while the lowest level was 27.5 in Wadi Al-Rabia region. On the other hand, no significant difference showed in chloride.

Also, when compared between the houses in each region, we found significant difference in TDS, TH, chloride and nitrate, while no significant difference in calcium in Zawia region. In Qasr ben Gheshir region, we found significant difference in TDS and calcium, while no significant difference in TH, chloride and nitrate. In Wadi Al-Rabia region, we found significant difference in chloride only, while no significant difference in TDS, TH, calcium and nitrate. On the other hand, no significant difference was showed in Zahra region.

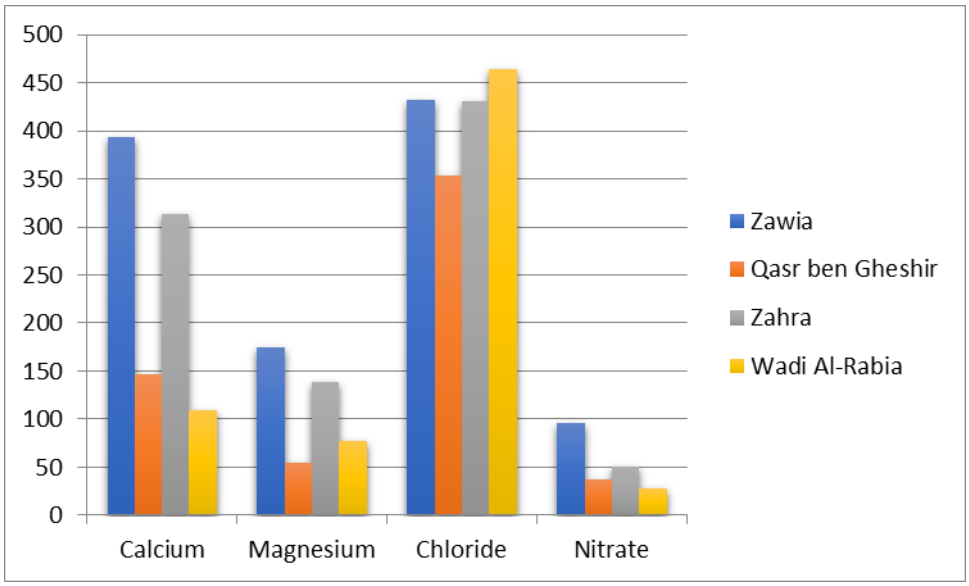

Figure 5 Comparison calcium, magnesium, chloride and nitrate between regions

Rise in mineral levels above the normal effects on Productive Performance of chicken; where higher than normal level of TH cause interfere with effectiveness of soap, disinfectants and medications. Also, High levels of TDS are causing harmful effects in poultry production. Higher levels of magnesium have laxative effects and may affect on performance if sulfate levels are high. The presence of nitrates often suggests bacterial contamination. Nitrate converted to the toxic form of nitrite by microorganisms found in the intestinal tract of the animal. Chronic nitrate toxicity causes poor growth, anorexia, and poor coordination. High level of calcium leads to deposit sand scale formation. Chloride may be detrimental if sodium level is higher than 50 mg/L.

4. Conclusion

The results showed a high physico-chemical parameters and bacteriological contamination of the drinking water. So, the treatment of water by using reverse osmosis units and continuous water chlorination are recommended, aiming to obtain satisfactory potable water.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest.

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