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Influence of Different Sources of Groundwater on Broiler Performance in New Valley Governorate.

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Abstract

This research project aimed to investigate the effect of different water sources (deep well, superficial well, tap water, filtered water, and healthy bottled water) on the performance and immune response of broiler chickens. A total of 250 one-day-old broilers were randomly allocated into five groups, with 50 birds in each group. The chickens were weighed weekly, and performance parameters such as feed intake (FI), body weight (BWT), body weight gain (BWG), and feed conversion ratio (FCR) were estimated. Serum samples were collected at different time points to examine the antibody titers of AI (H9) and ND vaccines using HI test. Water analysis showed higher numerical values in superficial well water. The results revealed significant differences among groups for most of the performance and immune parameters. Groups 4 (F) and 5 (H) had higher records for BWT, BWG, and FCR. However, there was a significant reduction in antibody response against ND and AI vaccines in groups 2 (W) and 1 (D). Heavy metal concentrations were also measured in different organs. Group 2 (W) recorded the maximum concentration of iron, lead, and manganese in the liver, while group 1 (D) recorded a higher level of cadmium. The maximum concentrations of iron and lead in the kidney were found in groups 1 (D) and 2 (W), while cadmium concentrations in groups 2 (W) and 3 (T) were significantly higher than in all other groups. The minimum concentrations of heavy metal in muscle were recorded in groups 4 (F) and 5 (H) with non-significant differences. These findings suggest that the quality of water sources can affect the performance, immune response, and heavy metal concentrations in broiler chickens.

Keywords: Broiler, Ground water, Heavy metal, Immunity, Residue.

Introduction

Water is the most important nutrient for poultry, and clean and safe water is essential to ensure that broilers function at their best. However, the impact of water quality on performance is sometimes overlooked or misinterpreted. As public concern about antibiotic use in animal feed pulls the chicken business away from antibiotics, water quality becomes increasingly important. Broiler performance is influenced by a variety of factors, including equipment, management methods, house environment, and housing type, but one of the most important and underappreciated is water quality (Oviedo, 2006). Water makes up a considerable amount of the chicken's body, ranging from 55 to 75 percent, making it vital for survival (Nesheim et al., 1979). Chickens can go far longer without food than they can without water (Scott et al., 1982). It is projected that variations in water content will have a greater impact on broiler performance than variations in feed content, and knowledge of water quality is critical for poultry production (Coetzee et al., 2000).

Water quality is usually related to health and production factors, animal product quality, and the watering systems of intensive poultry production systems. Factors that affect the quality of drinking water in chicken farms include pH, total hardness, mineral content, and microbial load (Singh, 2019). High levels of specific water physiochemical, such as pH, total dissolved solids, nitrite, and salinity, influenced feed intake and reduced broiler chick body weight (Reutor, 2010).

Heavy metals accumulate in the liver and kidneys of chickens, and metal contamination of poultry diets, drinking water, and processing are the main sources of metals in chicken meat. Toxic consequences of heavy metals in chickens include feed refusal, weight loss, low digestibility, organ failure, and death, while kidney and liver damage, anemia, changes in the central nervous system, and cancer are all toxic effects in higher species (Demirezen and Uruc, 2006; Mariam and Nagre, 2004; Hassan et al., 1998).

The biggest problem facing the commercial poultry industry is infectious disease, and the two most dangerous pathogens affecting chicken flocks worldwide are Newcastle disease (ND) and avian influenza (AI). Both diseases can be treated by utilizing viral vaccinations, live and inactivated (Swayne and King, 2003). Under low risk of challenge with mesogenic and velogenic strains in the field, vaccination via drinking water is sufficient. The efficacy of this technique varies depending on the quality of the water, and water quality can be assessed in a variety of ways, including checking for bacteria and other microorganisms, quantities of minerals found naturally in the water, and other chemical and physical characteristics. The relevance of limits placed on chemical criteria defining water quality must be understood (Sluis, 2002).

Materials and Methods

Experimental Design and Animal Care

We raised 250 unsexed broiler chicks on a balanced formulated diet free from any additives from day 1 to day 35. Prior to the experiment, chicks were vaccinated against Newcastle disease (ND) and avian influenza (H9). The chicks were weighed and randomly allocated into five groups (G1: D, G2: W, G3: T, G4: F, and G5: H) based on their water source: deep well, superficial well, tap water, filtered water, and healthy bottled water, respectively.

Water Analysis

Water samples from different sources used in the experiment were collected for physical analysis, including color, odor, taste, temperature, pH, electrical conductivity (EC), total hardness (TH), and total dissolved solids (TDS) according to the HACH Company (2003). The levels of lead (Pb), iron (Fe), manganese (Mn), and cadmium (Cd) were determined using standard methods of the American Public Health Association (APHA, 1998).

Performance Parameters

Initial body weights of chicks were recorded at day 1 and were randomly allocated into five groups with the same average weight (45-47gm). We measured feed intake (FI), body weight gain (BWG), body weight (BWT), and feed conversion ratio (FCR) on a weekly basis according to Hassan et al. (2012).

Immune Parameters

At days 1, 7, 15, 25, and 35, we collected two milliliters of blood from five birds per group (except for day 1, which was collected by slaughtering) from the wing vein. Blood was centrifuged, and serum was analyzed for the antibody titers of ND and AI H9 virus using the HI test as described by the Office International des Epizooties (OIE, 2000).

Heavy Metal Residues in Different Tissues

At 35 days of age, we randomly selected five birds from each group for detection of heavy metal residues in their muscle, liver, and kidney in accordance with Hseu (2004).

Statistical Analysis

Data were edited using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA). Normality and homogeneity of variance were tested using the Levene and Shapiro-Wilk tests, following the procedure outlined by Razali and Wah (2011). To compare significant differences between the permissible limits and the means of heavy metals and trace elements in different tissues and water quality, we used a one-sample t-test (Proc ttest; SAS., 2012 version 9, Cary, NC, USA) according to the guidelines provided by SAS Institute Inc (2012).

Results

Table 1: Physicochemical parameters of different water sources used in the experiment.

Parameter	Water sources					MIN	MAX	Water quality standard	
Physicochemical Examination	G1(D)	G2(w)	G3(T)	G4(F)	G5(H)			WHO (2011)	ECS (1994)
Turbidity (NTU)	2.51	7.11	1.05	0.20	0.13	0.13	7.11	0-4 NTU	---
Odor	Inoffensive	Inoffensive	Inoffensive	Inoffensive	Inoffensive	---	---	---	---
Temperature	45	29	32.5	20.5	20.4	20.4	45	---	---
Taste	Palatable	Palatable	Palatable	Palatable	Palatable	----	---	---	---
PH	7.04	6.47	7.09	7.13	7.15	6.47	7.15	6.8-8.5	7
EC mg/L	214.06	692.19	200	25	323.44	25	692.19	≤500 mg/L	---
TDS mg/L	137	443	128	16	207	16	443	≤500 mg/L	---
Total Hardness mg/L	63.5	190.1	50.4	11.6	123.5	11.6	190.1	180.0-200.0 mg/L	500
Fe mg/L	4.2	10.7	0.4	0.08	0.38	0.08	10.7	0.3 mg/L	1.0 mg/L
Mn mg/L	0.01	0.50	0.01	0.01	0.01	0.01	0.50	0.05 mg/L	---
Pb mg/L	0.13	0.26	0.28	0.01	0.002	0.002	0.28	0.01 mg/L	0.05
Cd mg/L	0.09	0.16	0.15	0.004	0.0001	0.0001	0.16	0.03 mg/L	0.01

EC=Electrical conductivity, TDS=Total dissolved solid

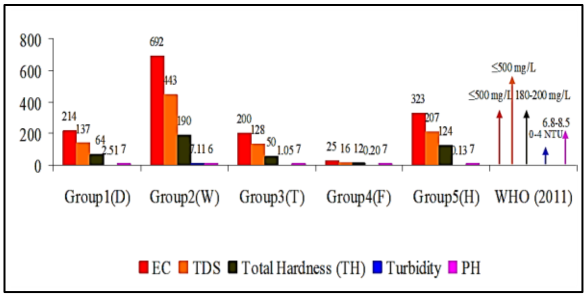

Fig. 1: Physicochemical parameters of different water sources used in the experiment.

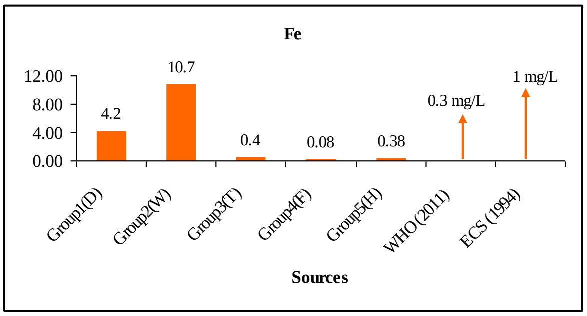

Fig. 2: Shows the levels of Fe in different water sources of the experiment.

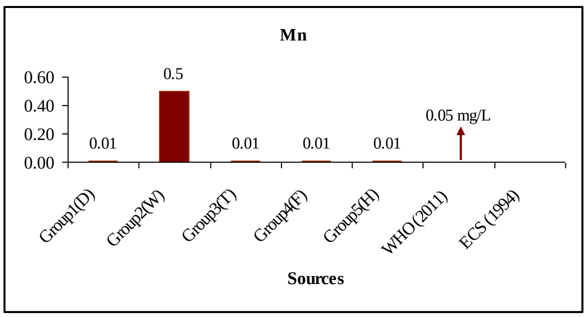

Fig. 3: Shows the levels of Mn in different water sources of the experiment.

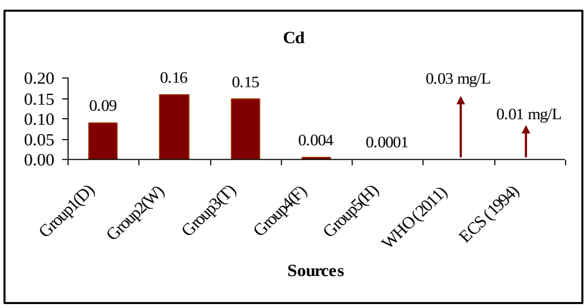

Fig. 4: Shows the levels of Cd in different water sources of the experiment.

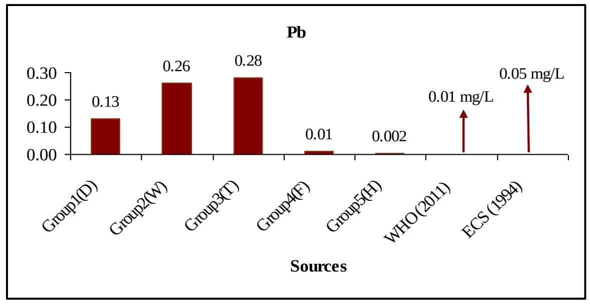

Fig. 5: Shows the levels of Pb in different water sources of the experiment.

Table 2: The effect of water source diversity on BWT of broilers at different weeks of the experiment.

Parameters	Weekly body weight (g/bird)					p-value
	Group1(D)	Group2(W)	Group3(T)	Group4(F)	Group5(H)	
1st week	201±3.67^{d}	196.2±9.21^{d}	218±8.45^{d}	236±1.00^{a}	228±6.81^{b}	0.0013
2nd week	610±12.14^{b,c}	552±27.86^{b}	677±13.28^{c}	730±10.95^{a}	705±20.18^{a}	0.0001
3rd week	974±42.58^{c}	976±68.29^{c}	1288±80.33^{b}	1526±11.33^{a}	1355±45.00^{b}	0.0001
4th week	1560±17.60^{b}	1670±56.12^{b}	2030±43.58^{a}	2120±46.36^{a}	2086±44.12^{a}	0.0001
5th week	1990±138.20^{b}	1980±174.35^{b}	2500±114.02^{a}	2640±60.00^{a}	2640±120.83^{a}	0.0001

* p-value was calculated according to one sample t test; ^{a,b} Means with different superscripts in the same row are significantly different (p<0.05, Tukey HSD test).

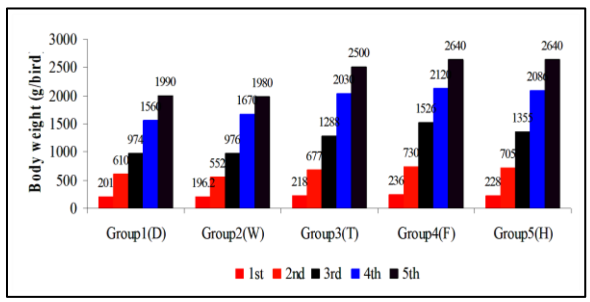

Fig. 6: Effect of water source diversity on BWT of broilers at different weeks of the experiment.

Table 3: Effect of water source diversity on BWG/week of broilers at different weeks of the experiment.

Parameters	Weekly body weight gain (g/bird)					p-value
	Group$_1$(D)	Group2(W)	Group3(T)	Group4(F)	Group5(H)	
1st week	155.4±2.84^{b}	150.6±7.07^{b}	172.4±6.68^{a,b}	190.4±0.80^{a}	182.4±5.45^{a}	0.0021
2nd week	409±8.14^{a,b}	355.8±17.96^{b}	459±9.01^{a}	494±7.41^{a}	477±13.65^{a}	0.0001
3rd week	364±15.91^{c}	424±29.66^{c}	611±38.11^{b}	796±5.91^{a}	650±21.58^{b}	0.0001
4th week	586±6.61^{b}	694±23.32^{a}	742±15.93^{a}	594±12.99^{b}	757±16.01^{a}	0.0001
5th week	430±29.86^{a,b}	310±27.29^{b}	470±21.43^{a}	520±11.81^{a}	528±24.16^{a}	0.0001

^{a,b} Means with different superscripts in the same row are significantly different (p<0.05, Tukey HSD test).

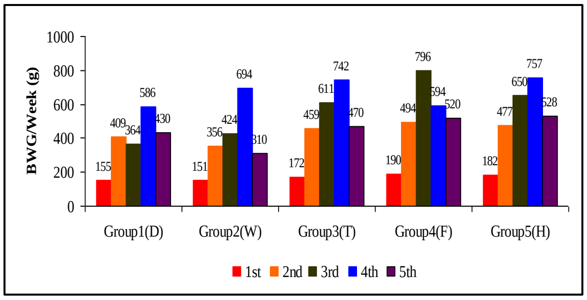

Fig. 7: Effect of water source diversity on BWG/week of broilers at different weeks of the experiment.

Table 4: Effect of water source diversity on FI/bird/day of broilers at different weeks of the experiment

Parameters	Feed intake (g/bird/day)					p-value
	Group1(D)	Group2(W)	Group3(T)	Group4(F)	Group5(H)	
1st week	17.85±0.32	17.5±0.82	17.85±0.70	15±0.10	14.28±0.42	0.1262
2nd week	89.28±1.77	88.57±4.47	85.71±1.68	78.57±1.17	80.71±2.31	0.0963
3rd week	128.57±5.26	125±8.75	121.42±7.57	125±0.93	128.57±4.26	0.3624
4th week	142.85±1.61	142.82±4.80	146.42±3.14	140±3.06	140±2.96	0.4421
5th week	170.71±11.85	167.85±14.78	175±7.98	171.42±3.89	177.85±8.14	0.1142

a,b Means with different superscripts in the same row are significantly different ($p<0.05$, Tukey HSD test).

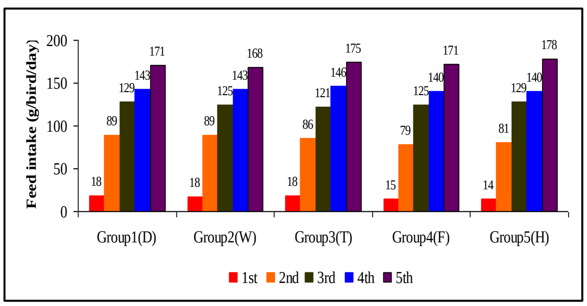

Fig. 8: Effect of water source diversity on FI/bird/day of broilers at different weeks of the experiment.

Table 5: Effect of water source diversity on FCR of broilers at different weeks of the experiment.

Parameters	FCR					p-value
	Group1(D)	Group2(W)	Group3(T)	Group4(F)	Group5(H)	
1st week	0.80±0.01^{a}	0.81±0.03^{a}	0.72±0.03^{b}	0.55±0.00^{c}	0.54±0.01^{c}	0.0110
2nd week	1.52±0.03^{a}	1.74±0.08^{a}	1.30±0.02^{a,b}	1.11±0.01^{b}	1.18±0.03^{b}	0.0002
3rd week	2.47±0.10^{a}	2.06±0.14^{b}	1.39±0.08^{c}	1.09±0.01^{d}	1.38±0.04^{c}	0.0001
4th week	1.07±0.01^{c}	1.44±0.04^{a,b}	1.38±0.04^{b}	1.64±0.03^{a}	1.29±0.02^{b}	0.0001
5th week	2.77±0.19^{b}	3.79±0.33^{a}	2.60±0.11^{b}	2.3±0.05^{c}	2.35±0.10^{c}	0.0001

a,b Means with different superscripts in the same row are significantly different ($p<0.05$, Tukey HSD test).

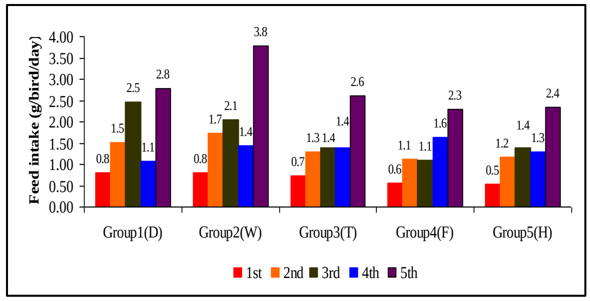

Fig. 9: Effect of water source diversity on FCR of broilers at different weeks of the experiment.

Table 6: Level of Heavy metals residues in liver (µg/g) of the experiment.

Parameters	Wells	Min.	Max.	Mean ± SE	Standard WHO (2001)	p-value*
Iron µg/g	Group1(D)	32.5	34	33.17±0.44^{a}	30-150 µg/g	ND
	Group2(W)	33.1	34	34.03±0.54^{a}		ND
	Group3(T)	17.6	19	18.20±0.41^{b}		0.001
	Group4(F)	9	11	10.00±0.57^{c}		0.001
	Group5(H)	13.6	14.2	13.83±0.18^{d}		0.001
Lead µg/g	Group1(D)	1.1	1.3	1.20±0.05^{c}	0.5 µg/g	0.001
	Group2(W)	6.5	7.5	6.96±0.29^{a}		0.001
	Group3(T)	4.9	6.2	5.50±0.37^{b}		0.001
	Group4(F)	0.32	0.40	0.35±0.02^{d}		0.066
	Group5(H)	0.33	0.42	0.38±0.02^{d}		0.081
Cadmium µg/g	Group1(D)	2.4	3.1	2.73±0.20^{a}	0.5 µg/g	0.001
	Group2(W)	2.1	3.2	2.63±0.31^{a}		0.001
	Group3(T)	1.5	3.1	2.5±0.50^{a}		0.001
	Group4(F)	0.2	0.4	0.30±0.01^{b}		0.046
	Group5(H)	0.4	0.7	0.56±0.09^{b}		0.186
Manganese µg/g	Group1(D)	0.60	0.75	0.67±0.04^{b}	0.5 µg/g	0.079
	Group2(W)	0.92	1.2	1.02±0.08^{a}		0.001
	Group3(T)	0.62	0.82	0.69±0.06^{b}		0.063
	Group4(F)	0.12	0.31	0.21±0.05^{c}		0.026
	Group5(H)	0.12	0.40	0.28±0.08^{c}		0.031

*p-value was calculated according to one sample t test; a,b Means with different superscripts in the same row are significantly different ($p<0.05$, Tukey HSD test).ND, non-determined

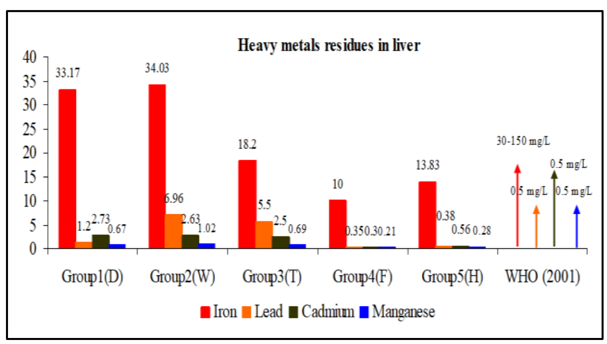

Fig. 10: Heavy metal residues in liver.

Discussion

The current study showed in Table (1) that the Superficial and deep wells recorded higher numerical value followed by tap water, respectively which exceeded the permissible limits of WHO (2011) (Table 1). However, filtered, and healthy bottled water recorded less numerical values which was within the acceptable range of WHO (2011) (Table 1). Our results agree with Abdel Wahab, (2008), Talha et al., (2008), Khalil and Khalafalla, (2011) (Table 1).

Our study proved that the increased levels of some chemicals (TDS, pH, TH, turbidity, and heavy metal concentration) cause changes in broiler behavior and performance by reducing BWT, BWG, FI and FCR by preventing nutrients from feed ingredients from being absorbed, which consistent with Brake and Hess, (2001), Reutor, (2010) and Singh, (2019) (Table 1).

Table (2 and 3) showed that the filter water group scored the highest significant values of BWT and BWG in (1st week), (2nd w), (3rd), (4th w), and (5thw), followed by bottled healthy water, tap, deep well and superficial well) respectively. The observed finding is harmony with EL-Saidy et al., (2015) and Yasser et al., (2016) (Table 2, 3). Ibitoye et al., (2013) reported higher numerical values of tap water than well water sources which in the same line with our results (Table 2, 3). The results at table (4) revealed that G3(T) reported highest mean values of FI in (1st, 2nd and 3rd W) while in 4th W reported the highest results in G3(T), at (5thw) G5 (H) recorded the highest values. Table (5) reported that G5(H) recorded highest significant mean values, on the contrary, it was observed that the results of G2(W) showed the significant decrease ($p<0.05$). The same results were reported by Abbas et al., (2008) and EL-Saidy et al., (2015), while the results disagree with Hassan et al. (2012) and Ibitoye et al., (2013) showed nonsignificant differences between different groups (Table 4, 5).

Results in Table (6) showed that the G2(W) recorded the maximum concentration of Fe, Pb and Mn residues in liver, while G1(D) recorded a higher level of Cd. On the other hand, the maximum concentrations of (Fe and Pb) concentrations in kidney were in the groups D and W. Cd concentration in groups W and T were significantly higher than all other experimental groups. The maximum concentration of Mn was recorded in the group W and D and they were higher than the standard limits, while the minimum concentrations were in the groups F and H which were lower than the standard limit of FAO (2012). A current study showed that the maximum concentrations of Fe and Mn in muscles was detected in the groups W. Collectively, all concentrations in the five experimental groups were lower than the standard limits WHO (2001). The highest concentrations of Pb and Cd was observed in the group T followed by W and D were exceeded the standard of WHO (2001). The results revealed that minimum concentration of heavy metal residue in liver, kidney and muscle were recorded in the groups F and H were lower than the standard limits WHO (2001) and FAO (2012).

The findings of this study are consistent with previous research by Ghlmpeeanu et al. (2012) and Khalil et al. (2012), which reported that Fe and Mn were accumulated in large amounts in the liver and kidney, respectively, while Pb and Cd residue were highest in the kidney, followed by the liver, and lowest in the muscle. Blagojevic et al. (2012) also reported similar results. However, Okoye et al. (2015) found that Pb and Cd accumulated in the liver > kidney > muscle.

In terms of the antibody response against ND and AI (H9) vaccines, the mean titers at zero day were 9.6 and 7.4, respectively. The highest mean titer of antibody response against ND vaccine of broiler chicks at 7 days was recorded in G3 (T) and G1 (D), while the lowest titer was observed in the (H) group. Chicks that received healthy bottled and filtered water achieved higher titers at 15 days of age, while the lowest mean titer was observed in G1 (D) and G2 (W). G5 (H) also reported a higher titer, but G2 (W) reported a lower titer at 25 days. The highest titer at 35 days was recorded in G4 (F), followed by (H and T) groups, while G2 (W) had the lowest titer. The results indicated a significant reduction of antibody response against ND Virus in G2(W) and G1(D), which received well water (superficial and deep). These results are consistent with previous studies by Khalil and Khalafalla (2011), EL-Saidy et al. (2015), and Yasser et al. (2016), but disagree with Aidaros et al. (1999).

The highest mean titer at 7 days of age was in G4 (F), while the lowest mean titer was recorded in the H group. The highest mean titer at 15 days was observed in F and H groups, while the lowest mean titer was observed in G1(D) and G2(W). The highest mean titer at 25 and 35 days was achieved by chicks supplied with bottled healthy water, while group T reported the lowest titer. Toylar (1969) noted that water quality and environmental temperature play an important role in building up the immune response of poultry against vaccines, which is consistent with the current study that highlights the effect of different water sources on antibody titer response against Avian Influenza (H9) virus disease, positively with high quality water.

Conclusion

Based on the data presented, it can be concluded that the use of well water (both superficial and deep) resulted in higher numerical values but was found to be polluted with heavy metals, including Fe, Mn, Pb, and Cd, which exceeded the permissible limits set by WHO (2011). This pollution had an adverse effect on broiler performance and immune parameters. Therefore, it is recommended to use healthy bottled and filtered water to maintain and improve the health and productivity of broiler chickens.

Conflict of interest

The authors haven't conflict of interest to declare.

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