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The Effect of the Ground Water of Three Different Locations on Some Morphometric Measurements of Broiler Chicken in Jeddah-Saudi Arabia

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Abstract: In this study, the ground water from three different regions in Saudi Arabia; Hada El-Sham (G_0), Om Al-Jood (G_1) and El-Wazeria (G_2) were tested to evaluate their suitability of using. For this purpose, the ground water were analysed and the physico-chemical characteristics were determined. The measured parameters were; pH, Total Dissolved Salts (TDS), Total Hardness (TH), Total Alkalinity (TA), cation (Na, K, Ca, Mg) and anion (NO_3, SO_4) concentrations. One hundred and currently from 21 day to six weeks broiler chicken were reared on the ground water of these locations and their morphometric measurements (body weight, feed and water consumption and feed assimilation) were recorded. From this study, it was noted that the ground water of G_0 and G_1 are very pure to be used in irrigation and drinking as they contain TDS less than 1100 ppm, whereas water of G_2 cannot be used as the TDS value is 2650 ppm. However, the ground water of the three regions is not suitable for any kind of industry. Reared chicken in G_0 were characterized by the highest growth rate despite of their lower rates of feed and water consumption. In G_1, chicken had medium rates of growth and water consumption with higher rate of feed consumption. While chicken from G_2 recorded the lowest growth rate and highest rate of water consumption due to the higher salt content of this water.

Key words: Ground water, morphometric measurements, broiler chicken

INTRODUCTION

Water is very important for animals as it helps in digestion, food absorption, excreting the harmful substances and excess salts by the kidney and helps the endocrine glands to secrete hormones (Barney and Van Horn, 2003). Birds consumed about 40% of the drinking water to regulate their body temperature and to keep it constant at 42°C (Allam, 1986). Carter and Sneed (1996) confirmed that the quality of water that offered to birds is very important as an increase in the salt content of water over the standard level leads to negative, devastating and some pathological effects on birds resulting in death. Thus ingestion of contaminated poultry is very hazard due to the accumulation of its heavy metal residues in chicken tissues (El-Sarha and Hussein, 1994).

Ibrahium (2006) Studying of the characteristics of water such as pH, Total Dissolved Salts (TDS), Total Hardness (TH), cations (Na, Ca, Mg and K) and anions (NO_3 and SO_4) and found that concentrations, is very important in determination its suitability for different vital activities drinking, irrigation, industry etc. Estimation of the total dissolved salts is a good means to determine the quality and suitability of water, as Habib and El-Hamen (1992) recorded that the level of TDS for irrigation tended to be less than 500 ppm. When TDS level is between 500 and 1100 ppm, water is only used for irrigating land with good sanitation. Over 2200 ppm, water will not be suitable for using at all. Standard levels of water were established by WHO (1996), as it was recommended to use water in different industries when TDS is in the range of 150-850 mg L^{-1} according to required industry. While the maximum level of TDS was 1500 mg L^{-1} to use such water for drinking purpose.

Earlier, Swedan (1970) mentioned that the ground water represents the major part of the freshwater on earth that suitable for using. However, ground water has higher content of salts than other sources of freshwater (e.g., rivers and lakes). Some other studies were carried out to evaluate the chemical properties of ground water in some regions of Saudi Arabia in order to determine the suitability of ground water in such regions for drinking, irrigation and industry. This evaluation was based according to standard measurements established by US Public Health Service (1962) and US Environmental Protection Agency (1975). Bazuhair *et al*. (1991) proved that ground water of Arabian shield according to standard

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levels of SASO (1984), is close to the international levels. By using Sodium Adsorption Ration (SAR), it was clarified that this ground water was suitable for irrigation and agriculture (Al-Yamani, 1983; Al-Ahmadi, 1984).

Therefore, the present study was carried out to test the suitability of the ground water in the three different locations and its effect on the morphometric parameters of chicken reared on it.

MATERIALS AND METHODS

Studied regions: Three regions in Makka El-Mokarama distrust, Saudi Arabia were chosen to test the quality of their ground water and its suitability for using. The first region is agricultural research station in Hada El-Sham (G_0) which is far from Jeddah by 150 km and is considered as the standard location. The second region is Om Al-Jood (G_1) which located 80 km away from Jeddah and the third region is El-Wazeria (G_2) at the south of Jeddah (Fig. 1).

Animal and experimental conditions: Broiler chicken was chosen for these experiments is species of poultry which are more resistant to diseases and are larger in weight. All the rearing conditions were adjusted to the optimum levels to provide suitable environment for chicken. Temperature was adjusted at 35°C in the incubation period and decreased gradually till the chicken growth was completed. Photoperiodism was adjusted by using continuous lighting program that was known to enhance the rates of growth and food assimilation. Seventy percent relative humidity was adjusted by using Psychrometer Sling.

Physico-chemical properties of water: The physicochemical parameters of water were measured according to Masoud *et al.* (2003). The recorded parameters were pH, Total Dissolved Salts (TDS), Total Hardness (TH), cations (Na, Ca, Mg and K) and anions (NO_3 and SO_4) concentrations. These parameters were recorded by using standard methods established by American Public Health Association APHA (1995).

Experimental procedures: For each region, 40 chickens were selected randomly after one day of egg hatching and supplied with sufficient food and water. The constitutes of the used food was 21.5% protein, 5.5% fat, 3.5% fibers, 5.5% ash, 0.9% Ca, 0.3% NaCl, 0.7% Phosphorus, 11 unit g^{-1} Vit. A, 3.5 unit g^{-1} Vit. 3D, 28 unit g^{-1} Vit. H and 3125 cal kg^{-1} Metabolizable Energy (ME).

The morphometric parameters were measured as following: to record body weight, 5 chickens were weighed individually each week by using an electrical balance. The consumed feed was recorded weekly by weighing the offered feed and the remained feed (Consumed feed = offered feed-remained feed). The consumed water was measured by using graduated

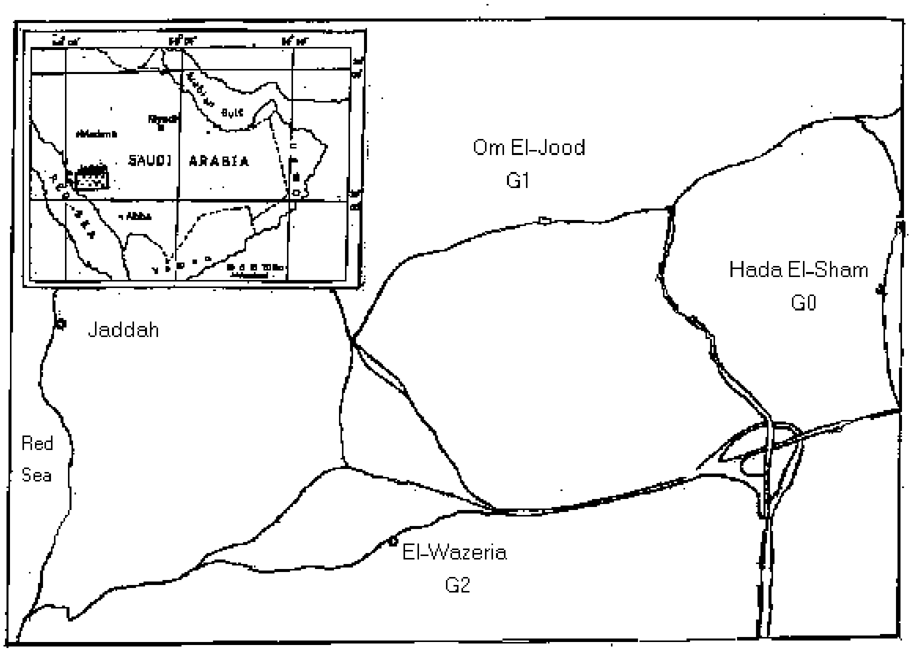

Fig. 1: Location map of the study sites

containers of 5 L. Faeces were collected weekly and the assimilated feed was calculated according to the following equation: Assimilated feed = consumed feed-faecal pellets (Kayed *et al*., 1990).

Statistical analysis: Statistical analysis was performed using the program SAS (Institute Inc. 1988, Cary, NC, USA), where data were analyzed by using one-way analysis of variance (ANOVA) (Sokal and Rohlf, 1981) to determine the effect of the water properties on the measured variables. Data were fitted to regression lines to estimate the rates of growth, feed consumption, water consumption and feed assimilation.

RESULTS AND DISCUSSION

Physicochemical properties of water: Figure 2 represents the measurements of the physico-chemical properties in the three studied regions; Hada El-Sham (G_0), Om Al-Jood (G_1) and El-Wazeria (G_2).

The present study found that the lowest level of TDS (915.67 ppm) was recorded in the ground water of G_0, while G_2 recorded the highest level (2650 ppm). TDS of the ground water of G_1 was found to be 1004.3 ppm. Thus G_0 and G_1 are considered to be good for using while G_2 is not suitable for plant growth. As Habib and El-Hamen (1992) considered the presence of TDS at level less than 500 ppm, water could be used safely. While over 2200 ppm, water could not be used for irrigation.

In the study of El-Bassam (2001), an increase in Na ion concentration in the ground water was considered a harmful factor on plant growth, because Na reacts with the soil and decreases the soil permeability. The present study agrees with this study, where the ground water of G_0 and G_1 contains a higher percentage of Na ions (150.7 and 194.7 ppm, respectively). This percentage makes this ground water not suitable for irrigation. Also the nitrate content of the ground water in these two regions is higher than that of G_2. Jetel and Paces (1978) referred the higher content of nitrate in the soil to the used fertilizers that leached to the ground water.

Data represented on Fig. 2 shows that pH in all tested ground water is in the range of 4-9 that range is suggested by Riley and Chester (1971) for all types of natural water. In this study, pH of ground water in all locations tended to be alkaline (6.56, 7.65 and 8.05 for G_0, G_1 and G_2, respectively). Clark (1980) and Bader (1993) contributed that an increase in the TDS and high carbon content resulted in a relative increase in pH. This contribution agrees with the present data where the ground water of G_2 contains high level of TDS and characterized by high pH.

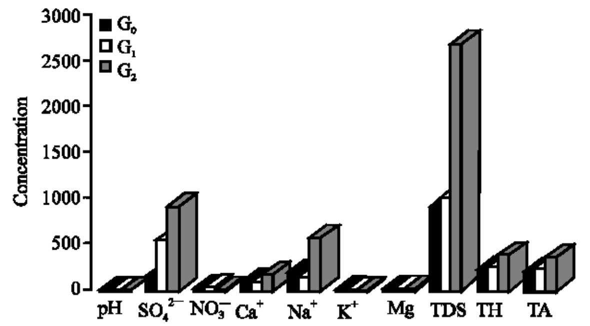

Fig. 2: Mean of the physico-chemical parameters measured in ground water of three different location

Also it is found that an increase or a decrease in pH is associated with corresponding response in TA for all tested water.

The Total Hardness (TH) of G_2 is the highest value (390 ppm) comparing with G_0 (234.4 ppm) and G_1 (254.3 ppm). Some previous studies found an inverse relationship between TH and pH level (Bin Dohaish, 2001). However, in the present work, the TH of the ground water was found to be in a direct relationship with pH. Behairy and Jaubert (1983) referred the high percentage of TH in water to the presence of $CaCO_3$ deposits from biological remains that leached to the soil and in turn to the ground water.

Morphometric measurements of the broiler chicken: Table 1 shows the average body weight, consumed feed, consumed water and assimilated feed of chicken reared on the ground water of the three studied regions. Body weights were taken from the first day after egg hatching to the sixth week. Care was taken to begin the experiments with chicken of nearly similar weights. All the chicken weights were in the range of 96.42 and 97.31 g in the three regions.

The present data show that the highest mean body weight was recorded for G_0 chicken (2208.71 g) followed by G_1 chicken (2191.92 g) and the lowest weight for G_2 chicken (2123.97 g). The body weight of chicken from different regions were significantly differed ($F = 9.89$; $p<0.003$). From Fig. 3a which represents the linear regression for the body weight in the three regions, it can be noted that the growth rate of G_0 chicken is higher than that of G_1 and G_2 which has the lowest rate.

The present study also found for all tested regions, that the percentages of weight increase in young chicken (after three weeks) (832.88, 823.29 and 847.35% for G_0, G_1 and G_2, respectively) were higher than those in older

Table 1: Mean of body weight (g), consumed food (g), consumed water (L) and assimilated food of the broiler chicken after three and six weeks raised in three different locations

		Three weeks				Six weeks			
Location	Initial weight	Body weight	Consumed food	Consumed water	Assimilated food	Body weight	Consumed food	Consumed water	Assimilated food
G_0	96.79±1.39	902.94±23.06	672.01±4.345	1.449±0.024	393.077±7.572	2208.71±19.40	1029.019±25.798	2.649±0.116	631.435±16.64
G_1	96.42±1.41	890.24±29.57	679.36±22.724	1.563±0.021	440.650±18.424	2191.92±29.36	750.910±27.986	2.712±0.087	453.740±10.936
G_2	97.31±1.42	921.87±14.24	676.79±6.935	1.592±0.034	377.000±2.600	2123.97±42.61	832.260±9.226	3.087±0.273	515.140±8.084

Each data represents mean of five replicates ±SE

chicken (144.61, 146.22 and 130.40%, respectively). These records agree with those obtained by Allam (1986) who noticed duplication in the chicken weight in the younger age and concludes that the increase in body weight decreased with age. While in another study carried by Al-Ghamdi (2004), a conclusion was established that there is no an obvious increase in chicken weight in their younger age without additive nutrients. Because of the incomplete formation of their gastrointestinal ducts and even if they are completed structurally, they are inactive functionally. This may be explained by the lower rate of digestive enzyme secretions (Sorogi, 1999).

Regarding the effect of the physico-chemical properties on the body weight of chicken, Runyan and Bader (1996) recorded that the body weight of chicken in their study was obviously affected by the levels of TDS and TH in the drinking water. In the present study, an increase in the TDS and TH resulted in a decrease in the body weight of chicken. Where chicken raised on the ground water of G_2 gained the lower body weight compared with the other two regions. This may be attributed to the higher levels of TDS and TH of those water. These findings agree with results which were obtained by many authors such as Allam (1986), Afifi *et al.* (1992) and Sorogi (1999).

On the other hand, Deyhim and Teeter (1995) recorded that when chicken were supplied with water contained NaCl or KCl with concentration of 3886-4985 ppm, an increase in their body weight was observed.

The decreasing body weight together with increasing water salinity may be attributed to an increase in TDS results in diarrhea and loss in weight (National Research Council, 1994) or causing an obvious stress in the vital systems in particular kidney that results in a delay in the chicken growth (Allam, 1986). Also a large quantity of calcium salts decreased the ability of the body to absorb digested food (El-Hadmy, 1994).

The present study recorded higher concentrations of Mg and S in the ground water in G_2 than those present in the other two regions (G_0 and G_1). These higher levels lead to a decrease in the growth rate of chicken raised in G_2. El-Hadmy (1994) confirmed that the suitable level of Mg is about 14 ppm, whereas the maximum quantity of Mg could be tolerated by the bird is 125 ppm and any increase above this amount in presence of have a laxative effect on the bird resulting in a decrease in the body weight.

Regarding the feed consumption, data of Table 1 showed that chicken raised in G_1 consumed feed higher than that in G_2 than G_0, where chicken of G_1 consumed about 1143.24 g per bird after six weeks whereas chicken of G_0 consumed only 1029.19 g per bird. Statistical analysis (one-way ANOVA) proved these significant differences in feed consumption between the three regions ($F = 20.09$; $p<0.001$).

It was also found that chicken consumed more feed in younger age (211.63, 219.68 and 222.27% for G_0, G_1 and G_2, respectively) than older age (53.12, 68.28 and 58.37, respectively). It can be seen from these percentages that the consumed feed in older chicken of G_0 is the lowest consumption comparing to other regions of the same age.

The data of feed consumption, in the three studied locations, were fitted as regression lines in Fig. 3b. These regression lines confirmed that the rate of feed consumption in G_1 is the highest rate while that of G_0 is the lowest rate.

In this study, it was observed that, in both younger and older chicken, the quantity of consumed water was higher in G_2 than that recorded in G_0 and G_1. As 3.087±0.27 L per bird was recorded after six weeks in G_2 whereas G_0 the mean of consumed water was 2.649±0.12 L per bird (Table 1). The difference in the consumed water between regions is significant statistically ($F = 8.38$; $p<0.004$).

Figure 3c shows the linear regression of the consumed water in the three regions. From that figure, it can be noted that the rate of water consumption in G_2 is higher than that of G_1 whereas G_0 recorded the lowest rate of water consumption.

After six weeks, the assimilated feed of chicken raised in G_1 (744.33) was highest while in G_0 (631.43) was the lowest. Statistically, there is a significant difference between the assimilated feed in the three locations ($F = 41.12$; $p<0.000$). Also the rate of feed assimilation (Fig. 3d) has the same previous cited trend.

From these data, it can be concluded that birds reared on the ground water of G_0 are characterized by a higher growth rate despite the lower rates of feed and water

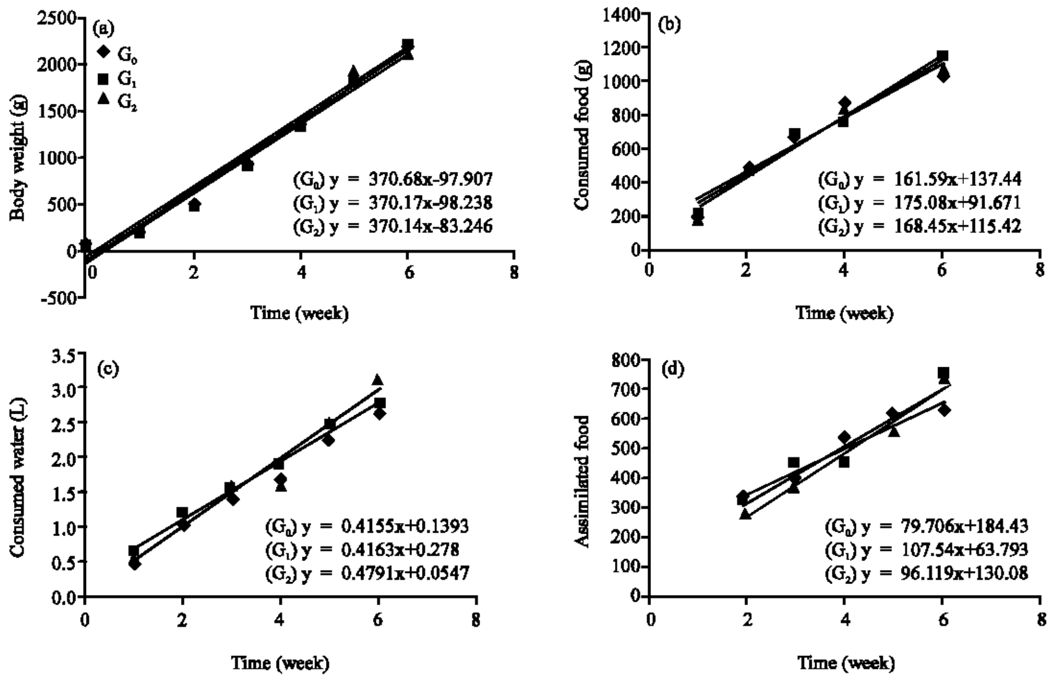

Fig. 3: Shows morphometric measurements as (a) rates of growth, (b) consumed food, (c) consumed water and (d) assimilated food of the broiler chicken from the initial to the sixth week raised in three different locations (G_0, G_1, G_2)

consumption. Thus most consumed feed converted to weight. Lie to building tissues this indicates that the ground water of this region is very suitable for chicken because of its lower salt content. Therefore, no stress on the physiological state was done. Chicken of G_1 recorded higher rates of feed consumption and assimilation with medium growth rate. It means that birds of this region had higher locomotor activities resulting in consuming a major part of food energy in locomotion, so their weight was considerably medium.

On the other hand, the ground water of G_2 contains higher levels of TDS and TH that resulting in diarrhea and pathological syndromes in the chicken reared in this region and an obvious decrease in their weight. Also, the higher rate of water consumption in this region may be explained due to the higher content of TDS, so birds overcome for the higher salt concentration by increasing their water consumption.

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