BENHA VETERINARY MEDICAL JOURNAL, VOL. 23, NO. 2, DEC 2012: 159-172

BENHA UNIVERSITY
FACULTY OF VETERINARY MEDICINE

BENHA VETERINARY MEDICAL JOURNAL

SOME CHEMICAL AND BACTERIOLOGICAL STUDIES ON DRINKING WATER IN AN OSTRICH FARM AT ISMAILIA PROVINCE

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A B S T R A C T

This study was carried out to evaluate the quality of drinking water in an ostrich farm through chemical and bacteriological examination with special emphasis to isolation and identification of some pathogenic microorganisms of public health concern. Water samples (n=210) were collected during summer season 2011 from an ostrich farm located at Elkassaseen, Ismailia province [main source, tanks (30 of each) and drinkers (n=15) of ostrich flocks at different age]. Results indicated that, the highest mean values of pH, ammonia, nitrites, nitrates, phosphates, chlorides, organic matters, total hardness, total solids**,** aerobic plate, enterobacteriacae, coliform and staphylococcus counts were recovered from drinkers water followed by tanks and main source. On the other hand, the lowest mean values of all chemical parameters and microbial counts were recovered from drinkers water collected from ostrich flock at age 1-10 days, then gradually increased to reach the maximum values in drinker's water of those collected at age 6-12 months. The overall occurrence % of *Salmonella*, *E. coli* and *Staphylococcus aureus* in all examined water samples were 5.2%, 11.9% and 8.6%, respectively, and the most predominant serotypes of *Salmonella* was *S. enteritides* (4 strains), and *S. typhimurium* (3 strains), while the most predominant serotype of *E. coli* was O126:K71 (B16) (7 strains), O86:K61 (B7) (6 strains), and O55:K59 (B5) (4 strains). From the obtained results we can conclude that sites of water sampling, systems of housing and management depending on the age of ostrich flock are greatly affecting the water quality. Water may act as a dangerous source of microorganisms to ostrich flock and consequently contribute to human infection with pathogens of public health importance.

KEY WORDS: Bacteriological profile, Chemical parameters, Drinking water, Ostrich

(BVMJ 23(2): 159-172, 2012**)**

1. INTRODUCTION

Ostrich (*Struthio camelus var domesticus*) is the largest and heaviest living bird. Throughout the world, there has recently been a shift in emphasis from production of leather to the production of meat as the primary product of ostrich. Ostrich produces red meat that is very similar in taste and texture to beef. The ostrich's meat has been reported to have high protein content and low cholesterol than any other protein of animal origin [22]. Ostrich farms started in Egypt in 1997. Since 1999, a marked increase in the number of ostrich flocks was seen in Egyptian farms following importation of breeding stocks from South Africa and Europe. By year 2000, ostrich chicks and layers were reared in 55 farms with a total population of 4000 birds [25]. Water is the most essential of all nutrients in the Ostrich diet. Approximately 60 to 85 percent of the daily nutrition (water and feed) of farm livestock is represented by water. The fat-free adult body's water content is relatively constant for many livestock species averaging 71 to 73 percent of body weight. Water quality depends on proper construction, protection and maintenance of the entire water system, including the source. Chemical properties of water are important parameters to determine its quality and its potential health impact. Water quality directly affects water consumption as the first effect of water restriction is reduced feed consumption with resulting lowered ostrich productivity; some toxic substances do not reduce palatability and they are more harmful than those that do [12]. Metal components such as calcium, magnesium, iron, and hardness are major factors contributing to diminish water quality, while, inorganic non-metallic components such as chlorides, phosphates, sulphates, nitrates and pH may make water unfit for consumption [1]. Water and air are important sources of serious diseases facing poultry breeding in our country; the drinking water must be free from organisms as it is a good vehicle for spreading contagious diseases among birds such as *E. coli*, *Salmonella*, and *Staph. aureus*. Direct contact with infected birds and indirect contact with contaminated environment are known to be important factors in the dissemination of microorganisms in poultry flock [24].

The aim of this study is to evaluate the quality of drinking water collected from different sites (main source, tanks, and drinkers) in ostrich farm through the following:

1- Chemical analyses of drinking water include estimation of pH, ammonia, nitrites, nitrates, phosphates, chlorides, organic matters, hardness, and total solids.
2- Bacteriological examinations of drinking water include Total aerobic plate count, Coliform count, Enterobacteriacae count and Staphylococcus count.
3- Isolation and identification of some food borne pathogens (*Salmonella*, *E. coli* and *Staph. aureus*).

2. MATERIALS AND METHODS

2.1. *Ostrich farm*

The present study was carried out in an ostrich farm, in Elkassaseen city, Ismailia province. It contained 1500 birds divided into four sectors (hatchery, reproduction, chick and grower pens).

2.1.1. Rearing unit I

It was used for keeping ostrich chicks from one day old up to 10 days of age. It consisted of one pen (5 x 5 meters) divided into two parts by wooden partition. Each part is used to keep 10-15 chicks and the rearing temperature was maintained at 32°C by using an electric heater. The floor was covered with rubber mat (replaced by a clean one twice a day).

2.1.2. *Rearing unit* II

It was used to keep chicks from 10 days up to 2 months old. It consisted of two rearing units; each one of them contained fourteen pens (7 pens on each side) and a passage way at the center (one meter wide). In front of each pen there is a run, to keep ostrich during the day light, and the floor of both run and pen made of concrete. The dimensions of each pen were 3×2.5×3 meter, while the dimensions of run were 7.5×3.0 meter surrounded by a fence of height about one meter and it sheltered . Stocking capacity of each pen was 15-20 chicks.

2.1.3. *Rearing unit* III

It was used to keep ostrich flock from 2 months up to 6 months old. It consisted of four runs, each one contains two pens (7.5×2.5×3.0 meter), while the dimensions of each run were 20×15 meter and surrounded with a fence of height about 1.2 meter). The stocking capacity of each pen was about 30 birds and the floor made of concrete.

2.1.4. *Grower unit* IV

It was used to keep ostrich from 6 months up to one year old and it consisted of 4 yards. The dimensions of each yard were (45×30 meter) and surrounded by a wire mesh fence with a height of 2 meter. The stocking capacity of each yard was 35-45 ostrich and the floor was of sandy soil and sheltered partially.

2.1.5. *Breeder unit*
It was used to keep ostrich over one year old. It consisted of 57 yards. The dimensions of each yard were 45×30 meter and it is partly sheltered and surrounded with a high wire mesh fence (2 meters height). The stocking capacity of the breeder yard was 15 ostrich (5 male and 10 females) and the yard floor was sandy soil.

2.1.6. *Water and watering system*
The water source to the farm was tap water (surface water, Ismailia canal). The watering system was carried out as showed in table below:

Age	*1-10 d*	*> 10-60 d*	*> 2 -6 months*	*>6- 12 months*	*> 2 years*
Type of drinkers	Pan and jar	Pan and jar	Medium flat container	Medium flat container	Large flat container (baneo)
Capacity (liter)	8	8	16	16	100
Water tanks	No	No	Yes	Yes	Yes
Antibiotics	Regular	Regular	Irregular	Irregular	Rare
Water sanitizers	No	No	No	No	No
Rate of daily drinkers water change	3 times/ day	3 times/ day	1-2 times/ day	1-2 times/ day	1-2times/ day

2.1.7. *Feed*
During the first 3 months, the chicks were feeding on a Broiler Poultry meal (20-22 % C.P.) supplemented with fine chopped greens as a fodder. Between 3 to 10 months, the feed was changed from starter to grower feed with a C.P. ratio of 16%. The protein level is maintained till the adult age and the quantity was increased correspondingly with age. The chopped green fodder to grower feed (ratio 2:1) was being implemented at the adult stage. After one year of breeding, the type of feed was being changed from grower to breeder feed (C.P. ratio is 20%). The chopped green fodder to feed ratio is maintained at 2:1.

2.1.8. *Temperature and Shelter*
The temperature inside rearing unit I was maintained at 32℃ by using an electric heater, while the temperatures inside other units were varied according to outdoor temperatures. Shelter was used to temporarily holding of the birds and it represented about 25% of the yard with a height of 2 meter from the floor.

2.2. *Water sampling*
Two hundred and ten water samples were collected during summer season, 2011. Those samples were collected after three visits, one month interval, from ostrich farm {main source, tanks (30 of each) and 150 from drinkers}. Ostrich flocks were reared in different groups according to their age as the follow: 1 day old chick to 10 days old; over 10 days to 60 days old, 2 to 6 months old; 6 to12 months old and over 2 years. The procedures of sampling were carried out according to the method described by APHA [8].

2.3. *Chemical examination of water*
Determination of pH, ammonia, nitrites, nitrates, phosphates, chlorides, organic matters, total hardness and total solids were carried out according to the methods described by APHA [8].

2.4. *Bacteriological examination of water*
2.4.1. Aerobic plate count, coliform count and Staphylococcus count were carried out according to ICMSF [23].

2.4.2. Enterobacteriaceae count was carried out according to AOAC [6].

2.5. *Isolation and identification of some food borne pathogens*

2.5.1. Isolation and identification of Salmonella was carried out according to Andrews and Hammack [4].

2.5.2. Isolation and identification of *E. coli* and *Staph. aureus* were carried out according to the procedures mentioned by Mackfaddin [27].

2.6. *Statistical Analysis*

Results were analyzed by software program according to Selvin [42].

3. RESULTS AND DISCUSSION

The data presented in tables 1 & 2 stated that the highest mean value of pH found in water samples collected from drinkers was 7.82±0.05 followed by that collected from tanks (7.66±0.03) and lastly those collected from the main source (7.50±0.05). While, the lowest mean value of pH was recorded in water samples collected from drinkers of ostrich flock at age 1-10 days (7.69±0.04), then gradually increased up to (7.86±0.04) at age 6-12 months then declined. All estimated pH values were within the range reported by WHO [47] who stated that the pH of the water lies between (6.5-8.5). The obtained results are in accordance with previous reported data [5, 45] but lower than the results recorded by Ali [2] and Byomi and Trabees [10] and higher than those reported by EL-Dahashan [13].

The highest mean value of ammonia in water samples collected from drinkers was (5.59±0.46 mg/L) followed by that collected from tanks (3.51±0.35 mg/L) and lastly that collected from the main source (2.06±0.13 mg/L). While, the lowest mean value of ammonia was recorded in water samples collected from drinkers at age 1-10 days (3.99±0.26 mg/L) then gradually increased to (5.78±0.43 mg/L) at age 6-12 months then declined. The mean values of ammonia in all examined water samples were over the maximum permissible limit (0.5 mg/ L**)** stated by WHO [46]. Moreover, APHA [7] stated that ammonia concentration in water is ranged from less than 10 ug/L in natural water to more than 30 mg /L in some waste water. Our results were nearly similar to those reported by Fadel [18] and Metawea [31] but they were higher than those obtained by Amany and Eman [3] and lower than those recorded by Aya [9]**.** On the other hand, WHO [47] has not set limits for ammonia in drinking water.

The highest concentration of nitrites was found in water samples collected from drinkers (0.86±0.05 mg/L) followed by that collected from tanks (0.54±0.04 mg/L) and lastly by that collected from the main source (0.51±0.05 mg/L). While the lowest concentration of nitrites was found in water samples collected from drinkers of ostrich flock at age 1 -10 days (0.62±0.04) and gradually increased to (0.87±0.05 mg/L) at age 6 -12 months then declined. The mean values of nitrites in all examined water samples were within the permissible limit (1 mg/L) set by WHO [47]. The results were nearly similar to those recorded by Ali [2]**,** but higher than those reported by EL-Dahashan [13] and Fadel [18] and lower than the results reported by Anwer *et al.* [5]. The variation in levels of nitrites in water samples may be attributed to the instability of nitrogenous compound and the conversion to other compounds under different condition as reported by Moubarak [34].

The highest mean value of nitrates was found in water samples collected from drinkers (41.15±1.87 mg/L) followed by that collected from tanks (31.46±1.51 mg/L) and lastly by that collected from the main source (27.88±1.36 mg/L). While, the lowest mean value of nitrates was recorded in water samples collected from drinkers of ostrich flock at age 1-10 days (34.77±1.34 mg/L) then gradually increased up to (43.35±1.49 mg/L) at age 6-12 months then declined. The mean values of nitrates in all examined water samples were over the permissible limit

(10 mg/L) stated by WHO [47]. These results are nearly agree with those recorded by Byomi and Trabees [10] but are higher than those reported by Amany and Eman [3] and Aya [9]**.** The high level of nitrates in water may be attributed to the contamination with fecal matter as well as the intensive use of nitrogenous fertilizers (ammonia, urea and nitrate) in agriculture lands at the area of our study [38].

The data clarified that the highest concentration of phosphates was found in water samples collected from the drinkers (4.80±0.19 mg/L) followed by those collected from tanks (3.76±0.19 mg/L) and lastly by those collected from the main source (3.66±0.17 mg/L). Alternatively, the lowest concentration of phosphates was found in water samples collected from the drinkers of ostrich flock at age 1-10 days (3.79±0.17 mg/L) and increased to (4.88±0.17 mg/L) at age 6-12 months then declined. The mean values of phosphates in all examined water samples were higher than the limit stated by Pattison [39] who mentioned that the upper limit of phosphates in water is 0.1 mg/L. The results are nearly similar to those reported by EL-Dahashan [13] and Metawea [31]**,** but higher than those recorded by Chapman [11]. On the other hand, WHO [47] has not set a limit for phosphate in drinking water. The high level of phosphates in water may be attributed to the disposal of agriculture drainage water (supper phosphate fertilizer) and/or sewage into water sources [18].

The highest mean value of chlorides was found in water samples collected from drinkers (169±10.5 mg/L) followed by those collected from tanks (140±11.3 mg/L) and finally by those collected from the main source (126±11.6 mg/L). Whereas, the lowest mean value of chlorides was recorded in water samples collected from the drinkers of ostrich flock at age 1-10 days (157±10.1 mg/L) then gradually increased to (184±7.3 mg/L) at age 6-12 months and finally declined. The mean values of chlorides in all examined water samples were within the permissible limit (250 mg/L) set by WHO [47]. The results are in accordance with those reported by Byomi and Trabees [10], but lower than those recorded by Helal *et al.* [21] and Radwan and Ali [40] while, higher than those was reported by Sayed [41].

The obtained data clarified that the highest concentration of organic matters was found in water samples collected from the drinkers (2.11±0.12 mg/L) followed by the water sample collected from tanks (1.49±0.10 mg/L) and lastly by that collected from the main source (1.14 mg/L). While the lowest concentration of organic matters was found in water sample collected from the drinkers of ostrich flock at age 1-10 days (1.73±0.09 mg/L) and gradually increased up to (2.40±0.08 mg/L) at age 6 -12 months then declined. The results were within the range reported by Chapman [11] who indicated that the level of organic matters in surface water is 20 mg/L or less in unpolluted water or greater than 200 mg/L in water receiving effluents. Similar results were obtained by Yoo and Boyd [48]**,** but these results are lower than those mentioned by Aya [9]**.**

The highest mean value of total hardness was found in water samples collected from drinkers (508±32 mg/L) followed by that collected from tanks (450±28.9 mg/L) and lastly by that collected from the main source (400±23.8 mg/L). Otherwise, the lowest mean value of total hardness was recorded in water samples collected from drinkers of ostrich flock at age 1-10 days (448.5±20.5 mg/L) then increased to (551±29.1 mg/L) at age 6 -12 months then declined. The mean values of total hardness in all examined water samples were higher than the permissible limit (100 mg/L) set by WHO [47]. Nearly similar levels of total solids were detected in water as reported by previous studies [10, 40], but higher levels were detected by Fadel [18].

The highest mean value of total solids was found in water samples collected from drinkers (1086±59.5 mg/L) followed by that collected from tanks (900± 69.8 mg/L) and lastly by that collected from the main source (800±52.2 mg/L). Although, the lowest mean value of total solids was recorded in water samples collected from drinkers of ostrich flock at age 1 -10 days (973±44.7 mg/L) then increased to (1226±47.7 mg/L) at age 6 -12 months and finally declined, the mean values of total solids in all examined water samples were exceeded the permissible limit (500 mg/L) set by WHO [47]. High level of total solids in all examined water samples may be attributed to pollution of water source with agriculture drain, sewage, waste water and industrial effluents. Similar results were obtained by Maysa *et al.* [28], while higher levels were recorded by EL-Dahashan [13] and Yoo and Boyd [48].

The statistical analysis of data showed that, there are significant differences ($p<0.01$) in means of pH, ammonia, nitrites, nitrates, phosphates, chlorides, organic matters, total hardness and total solids of between the results of water samples collected from drinkers and those collected from the main source. Furthermore, there are significant differences ($p<0.05$) in means of pH, ammonia and organic matters in between the results of water samples collected from drinkers and those collected from tanks. Additionally, significant differences ($p<0.05$) in mean values of pH, ammonia and organic matters between the results of water samples collected from tanks and those collected from the main source. These results indicated that the drinkers were the most exposed site to contamination followed by tanks and the main source and this may be attributed to the addition of some drugs and vaccines in water tanks, in addition to the environmental contamination of both tanks and drinkers with ostrich dropping, feed particles, dust, rodent, wild birds and sand from floor especially if the tanks left open and the drinkers water not frequently changed every day.

The statistical analysis of the data also showed that there are significant differences ($p<0.01$) between means of all examined parameters of water samples collected from the drinkers of ostrich flocks at age (1-10 days, 10 - 60 days) and 6 -12 months. On the other hand, no significant differences in the mean values of all examined parameters of water samples from flocks at age (1-10 days, 10 - 60 days and 2 -6 months) were reported. Furthermore, no significant differences in the mean values of all parameters were recorded in drinkers' water samples from the flock at age 6 -12 months and those collected from the flock at the age over 2 years. These recorded results indicated that water samples collected from the drinkers of ostrich flock at age 6-12 months were highly contaminated followed by water samples collected from the flocks over 2 years, 2-6 months, 10- 60 days and the flock at age 1 -10 days. The high level of contamination in drinkers' water from flocks at age 6-12 months and over 2 years flock may be attributed to the sandy floor of yards, type of drinkers (medium and large flat containers), high stocking density, dry feed particles, the frequency of changing drinkers' water (1-2 times daily), and system of housing (yard). All those factors increase the liability of drinkers to environmental contamination. On the other hand, the low level of contamination in drinkers' water from flocks at age 1-10 days and 10-60 days may be attributed to the frequent change of drinkers' water (three times/day), rubber and concrete floor (regularly cleaned), the absence of water tanks (water obtained directly from the main source) and the absence of dry feed (hay). The ostrich flocks at this age were reared in pens which reduce the liability of drinkers to environmental contamination.

The obtained results in Table 3 clarified that the highest mean values of aerobic plate count, enterobacteriacae count, coliform count and Staphylococcus count were recovered from water samples collected from drinkers ($2.8\times10^6\pm 6.4\times10^4$/mL, $3.1\times10^4\pm6.0\times10^3$/mL, 1.9×104±3.2 $\times10^3$ /100 mL and $3.8\times10^2\pm 0.4\times10^2$ /mL, respectively), followed by the means of microbial counts isolated from the water samples collected from tanks (3.5×10^5-4.2 ± 10^4/mL, 5.5×10^3- 4.9 ± 10^2/mL, 3.5×10^3- 3.3 ± 10^2/100 mL and $2.1\times10^2\pm0.3\times10^2$/mL respectively) then the means of microbial counts isolated from water samples collected from the main source ($8.9\times10^4\pm1.6\times10^4$/mL, $2.3\times10^3\pm3.9\times10^2$/mL, $1.8\times10^3\pm2.0\times 10^2$/100 mL and $1.0\times10^2\pm0.7\times10$, respectively.

Table 1 Chemical analysis of water samples collected from ostrich farm at different sites (mg/l) (n =30).

Parameter		*Main source*	*Tanks*	*Drinkers*
pH	Min- Max	6.92 - 7.89	7.44 - 7.95	7.49- 8.28
	Mean ± SE	7.50 ±0.05 ^{a}	7.66± 0.03 ^{b}	7.82 ±0.05 ^{c}
Ammonia	Min- Max	0.86 - 3.14	1.40 -7.83	2.66 - 9.92
	Mean ± SE	2.06 ± 0.13 ^{a}	3.51± 0.35^{b}	5.59±.0.46^{c}
Nitrites	Min- Max	0.11- 0.89	0.19- 1.02	0.38- 1.40
	Mean ± SE	0.51± 0.05 ^{a}	0.54± 0.04 ^{a}	0.86± 0.05 ^{b}
Nitrates	Min- Max	10.78- 35.2	19.04 - 42.73	26.09- 59.65
	Mean ± SE	27.88± 1.36 ^{a}	31.46± 1.51^{a}	41.15± 1.87 ^{b}
Phosphates	Min- Max.	2.26- 4.87	2.56- 5.40	2.96- 6.40
	Mean ± SE	3.66± 0.17 ^{a}	3.76± 0.19 ^{a}	4.80± 0.19 ^{b}
Chlorides	Min- Max	48- 206	66- 231	97- 265
	Mean ± SE	126± 11.6 ^{a}	140± 11.3 ^{ab}	169± 10.5 ^{b}
Organic matters	Min- Max	0.6- 1.83	1.0- 2.8	1.4- 3.5
	Mean ± SE	1.14± 0.09 ^{a}	1.49± 0.10 ^{b}	2.11± 0.12 ^{c}
Total hardness	Min- Max	275- 616	330- 712	390- 915
	Mean ± SE	400± 23.8 ^{a}	450± 28.9 ^{ab}	508± 32 ^{b}
Total solids	Min- Max	400- 1200	500- 1400	700-1700
	Mean ± SE	800± 52.2 ^{a}	900± 69.8 ^{ab}	1086± 59.5 ^{b}

Values with different letters in the same raw are significantly different at $P<0.05$

Table 2 Chemical analysis of water samples collected from drinkers of ostrich flocks at different age (mg/l) (n =30)

		------------------- *Age of ostrich* -------------------				
Parameters		1^{st} -10^{th} day	10^{th} -60^{th} day	2^{nd} -6^{th} Month	6^{th} -12^{th} month	Over 2years
pH	Min-Max	7.49-8.06	7.51-8.17	7.52- 8.23	7.59-8.28	7.56-8.14
	Mean ±SE	7.69 ±0.04^{a}	7.71±0.04^{ac}	7.73±0.05^{a}	7.86±0.04^{bd}	7.81±0.03^{ad}
Ammonia	Min-Max	2.66-6.50	2.70-7.5	2.85- 8.30	3.25-9.92	3.02- 9.01
	Mean ±SE	3.99±0.26^{a}	4.55±0.34^{a}	4.78±0.38^{ac}	5.78±0.43^{bc}	5.17±0.39^{bc}
Nitrites	Min-Max	0.38-0.92	0.41-1.09	0.45 – 1.18	0.54-1.40	0.50-1.22
	Mean ±SE	0.62±0.04^{a}	0.68±0.05^{ac}	0.74±0.05^{ad}	0.87±0.05^{bd}	0.80± 0.05^{bcd}
Nitrates	Min-Max	26.1- 45.2	27.3-49.00	27.62- 51.1	33.6- 59.65	28.71-53.5
	Mean ±SE	34.77±1.34^{a}	37.01±1.51^{ad}	38.81±1.53^{ac}	43.35±1.49^{c}	40.10±1.48^{bcd}
Phosphates	Min-Max	2.69-5.48	2.75-5.94	2.89- 6.10	3.52-6.40	3.12-6.31
	Mean ±SE	3.79±0.17^{a}	4.15±0.20^{ac}	4.20±0.19^{ac}	4.88±0.17^{bd}	4.67±0.20^{bc}
Chlorides	Min-Max	97-237	103-242	125-249	165-265	145-259
	Mean ±SE	157.0±10.1^{a}	166±95^{a}	174±8.5^{ac}	199.0±5.3^{bd}	184.0±7.3^{acd}
Organic matters	Min-Max	1.4-2.63	1.6-2.9	1.85-3.13	2.0-3.50	1.92- 3.20
	Mean ±SE	1.73±0.09^{a}	1.88±0.07^{ac}	2.16±0.09^{cb}	2.40±0.08^{b}	2.29±0.09^{b}
Total hardness	Min-Max	390-720	394-735	395- 805	339-951	394- 850
	Mean ±SE	448.5±20.5^{a}	460.0±20.3^{ac}	466.0±20.4^{ab}	551.0±29.1^{b}	513.0±32.2^{ab}
Total solids	Min-Max	700-1400	730-1500	750-1600	800-1700	780-1600
	Mean ±SE	973.0±44.7^{a}	1047.0±50.9^{ac}	1076.0±54.4^{acd}	1226±47.7^{bd}	1157.0±47.6^{bc}

Values with different letters in the same raw are significantly different at $P<0.05$

The obtained results in Table 4 indicated that, the lowest mean values of aerobic plate count, enterobacteriacae count, coliform count and Staphylococcus count were recovered from water samples collected from the drinkers of ostrich flock at age 1-10 days (7.7×105± 1.3× 105/mL, 7.8×103± 1.0× 103/mL, 6.7×103± 7.5× 102/100mL and 2.4×102± 0.2× 102 /mL, respectively), then the mean values of all microbial counts gradually increased to reach the maximum level in the drinkers water samples that collected from the ostrich flock at age 6 -12 months (2.8×106± 5.7× 105 /mL, 3.1×104± 6.1× 103 /mL, 1.9 ×104± 2.6× 103/100 mL and 4.3 ×102± 0.3× 102/mL, respectively) then the mean values of microbial counts were declined. These results were in accordance with the results reported by former authors [19, 32]. However, higher microbial counts were reported by Byomi and Trabees [10] and EL-Dahashan [13]**,** while lower microbial counts were obtained by Shaban and Ali [43]. These variations in microbial counts in water samples may be attributed to the exposure of water source to different levels of pollution due to the different human and animal activities around the water source. Occurrence of enterobacteriaceae members in food reveals the presence of either pathogenic and/or spoilage bacteria which may represent a public health risk since it causes certain well defined intestinal syndromes; other members are entirely commensally in the gut but are associated with infection in other tracts and tissues [26]. Moreover, Staphylococcal food poisoning is caused by ingestion of food containing enterotoxins secreted by *Staph. aureus* and characterized by nausea, vomiting, abdominal pain and prostration often with diarrhea but without fever, food poisoning usually develop approximately 1-6 hours after ingestion of contaminated food [14].

Statistical analysis of data presented in Table 3 showed that there are significant differences ($p<0.01$) between the means of all microbial counts in water samples collected from drinkers and those collected from both the main source and tanks. This may be attributed to the exposure of water in both tanks and drinkers to higher levels of environmental contamination compared to the water samples collected from the main source. The statistical analysis of data presented in Table 4 also clarified that there were significant differences ($p< 0.01$) between the mean values of aerobic plate counts and enterobacteriacae counts in the drinkers' water samples collected from the ostrich flocks at age 1-10 days, 10 -60 days and those collected from the ostrich flocks at ages 2-6, 6 -12 months, and over 2 years. Moreover, there were significant differences between the means values of coliform counts and Staphylococcus counts in the drinkers' water samples collected from the ostrich flocks at age 1-10 days and those collected from the ostrich flocks at age 10 -60 days, 2-6 months, 6 -12 months, and over 2 years. On the other hand, no significant differences between the mean values of Aerobic plate count and enterobacteriacae count in drinkers' water samples collected from the ostrich flocks at old age (over 2 months and up to/over 2 years). Over and above no significant differences were observed between drinkers' water samples collected from the ostrich flocks at young age (from day 1 and up to 2 months). Moreover, no significant differences were observed between the mean values of coliform count and Staphylococcus count in drinkers water samples collected from the ostrich flocks at age 10 -60 days and 2 -6 months. Also, no significant differences were observed between water samples collected from flock at age 6 -12 months and over 2 years old. The obtained results indicated that the higher level of microbial contamination was observed in the water samples collected from the drinkers of the old age (over 2 months) compared to the water samples of the drinkers of young age (under 2 months). This may be attributed to the exposure of drinkers water of old ostrich flocks to a higher level of environmental contamination since the ostrich flocks were housed in a sandy floor yard and the drinkers were medium to large flat containers and not regularly cleaned. Additionally, the use of antibiotics into water is irregular or rare. On the other hand, low microbial counts in drinkers' water from the young flock were observed (under 2 months) and this may be attributed to the conditions where ostrich flocks at this age were kept in closed pens with rubber or concrete floor in addition to the use of pan and jar drinkers which are less liable to contamination. Furthermore, the drinkers are frequently changed (3times/day), no water tank (water obtained directly from main source), and the addition of antibiotics into drinkers water at young age was carried out regularly. All those factors play an important role in the control of microbial growth in water.

Table 3 Microbial counts of examined water samples collected from ostrich farm at different sites (n= 30).

Microbial count		Main source	Tanks	Drinkers
Aerobic plate count/mL	Min.- Max	0.11-3.50 $\times10^{5}$	0.79-8.30 $\times10^{5}$	0.022-1.200 $\times10^{7}$
	Mean ± SE	8.9 ±1.6 $\times10^{4a}$	35.0±4.2 $\times10^{4\,b}$	280±6.4 $\times10^{4\,c}$
Enterobacteriaceae C./mL	Min.-Max.	0.48-6.50 $\times10^{3}$	0.11-1.20 $\times10^{4}$	0.24-9.30 $\times10^{4}$
	Mean ±SE	23.0±3.9 $\times10^{2a}$	55.0±4.9 $\times10^{2\,b}$	31±6.0 $\times10^{3\,c}$
Coliform count/100 mL	Min.-Max.	0.39-3.50 $\times10^{3}$	0.74-7.2 $\times10^{3}$	0.19-4.70 $\times10^{4}$
	Mean ±SE	18±2.0 $\times10^{2a}$	35.0±3.3 $\times10^{2\,b}$	19.0±3.2 $\times10^{3c}$
Staph. count / mL	Min.- Max	0.5-1.5$\times$ 10^{2}	1.2-3.5 $\times10^{2}$	1.9-5.2$\times$ 10^{2}
	Mean ± SE	1.00± 0.07 $\times10^{2\,a}$	2.1±0.3 $\times$ 10^{2b}	3.8±0.4 $\times10^{2c}$

Values with different letters in the same raw are significantly different at P<0.05. The mean values of staph. Count was calculated according to positive samples.

Table 4 Microbial counts of water samples collected from drinkers of ostrich flocks at different age (n =30)

Age	*Aerobic P.C./mL* Min.- Max Mean ±SE	*Enterobact. C./mL* Min. -Max Mean ±SE	Coliform C/100 *mL* Min.-Max. Mean ±SE	*Staph. C. / mL* Min.- Max. Mean ±SE
1st -10th day	2.2×10^{5}- 2.6×10^{6}	2.4×10^{3}- 1.4×10^{4}	1.9×10^{3}- 1.4×10^{4}	1.9×10^{2}- 3.2×10^{2}
	$7.7\times10^{5}\pm1.3\times10^{5a}$	$7.8\times10^{3}\pm1.0\times10^{3a}$	$6.7\times10^{3}\pm7.5\times10^{2a}$	$2.4\times10^{2}\pm0.2\times10^{2a}$
10th -60th day	2.3×10^{5}- 4.2×10^{6}	2.9×10^{3}- 2.2×10^{4}	1.9×10^{3}- 1.9×10^{4}	2.1×10^{2}- 3.9×10^{2}
	$9.9\times10^{5}\pm2.0\times10^{5a}$	$8.9\times10^{3}\pm1.3\times10^{3a}$	$1.0\times10^{4}\pm1.2\times10^{3b}$	$3.1\times10^{2}\pm0.2\times10^{2b}$
2nd -6th month	2.6×10^{5}- 7.3×10^{6}	3.2×10^{3}- 4.5×10^{4}	2.1×10^{3}- 2.9×10^{4}	2.3×10^{2}- 4.2×10^{2}
	$2.2\times10^{6}\pm4.0\times10^{5b}$	$2.0\times10^{4}\pm3.5\times10^{3b}$	$1.1\times10^{4}\pm1.6\times10^{3b}$	$3.4\times10^{2}\pm0.2\times10^{2bc}$
6th -12th month	3.0×10^{5}- 8.6×10^{6}	3.9×10^{3}- 9.3×10^{4}	2.2×10^{3}- 4.5×10^{4}	3.0×10^{2}- 5.2×10^{2}
	$2.8\times10^{6}\pm5.7\times10^{5b}$	$3.1\times10^{4}\pm6.1\times10^{3b}$	$1.9\times10^{4}\pm2.6\times10^{3c}$	$4.3\times10^{2}\pm0.3\times10^{2de}$
Over 2nd years	2.9×10^{5}- 1.7×10^{7}	3.5×10^{3}- 5.5×10^{4}	2.1×10^{3}- 3.7×10^{4}	2.5×10^{2}- 4.5×10^{2}
	$2.5\times10^{6}\pm6.0\times10^{5b}$	$2.3\times10^{4}\pm3.4\times10^{3b}$	$1.5\times10^{4}\pm2.1\times10^{3bc}$	$3.7\times10^{2}\pm0.2\times10^{2ce}$

Values with different letters in the same column are significantly different at P<0.05. The mean values of *Staph. Count* was calculated according to positive samples.

Table 5 showed that, the highest detection (%) of Salmonella, *E. coli* and *Staphylococcus aureus* were recovered from the drinkers' water (6.7%, 14.7% and 11.3 % respectively) followed by those collected from tanks (3.3%, 6.7% and 3.3%, respectively), in addition to only one isolate of *E. coli* recovered from water samples collected from main source with incidence of 3.3%. On the other hand, neither Salmonella nor *Staphylococcus aureus* were recovered from water samples collected from the main source. The results in Table 6 clarified that the highest incidence (%) of Salmonella, *E. coli* and *Staphylococcus aureus* were recovered from the samples of the drinkers' water collected from the ostrich flock at age 2- 6 months (13.3 %, 23.3% and 20% respectively) followed by the samples of drinkers' water collected from the ostrich flock at age 6 -12 months (10%, 20% and 13.3%, respectively), then by those collected from the flock at age over 2 years (6.7%,13.3% and 10%, respectively. On the other hand, the lowest incidence (%) of Salmonella, *E. coli* and Staphylococcus spp. were observed in samples collected from drinkers' water collected from the ostrich flocks at age 1-10 days and 10 -60 days. Moreover, no Salmonella was recovered from the drinkers' water of the ostrich flock at age 1-10 days. The overall incidence of Salmonella, *E. coli* and *Staphylococcus aureus* in all examined water samples (210) were 5.2%, 11.9% and 8.6 %, respectively. Almost similar detection rate was reported by earlier studies [29, 30, 37]. Higher incidences were obtained by El-Zarka [16], but lower occurrence % was recorded by Gamila [19] and Mohamed Basha [33]. The variations of occurrence of the isolated microorganisms in water samples among farms may be attributed to the applied hygienic measures in each farm, system of housing, water source, and sites of sampling, season and the health status of poultry flock.

Table 5 Occurrence of *Salmonella, E. coli* and *Staph. aureus* in drinking water samples collected from ostrich farm at different sites

Microorganism	Main source			Tanks			Drinkers			Total		
	Total number	Positive samples		Total number	Positive samples		Total number	Positive samples		Total number	Positive samples	
		n	%		n	%		n	%		n	%
Salmonella	30	0	0.0	30	1	3.3	150	10	6.7	210	11	5.2
E. coli	30	1	3.3	30	2	6.7	150	22	14.7	210	25	11.9
Staph. aureus	30	0	0.0	30	1	3.3	150	17	11.3	210	18	8.6

Table 6 Occurrence of *Salmonella, E. coli* and *Staph. aureus* in drinking water samples collected from ostrich flocks at different age

Age of ostrich	Total number	1st -10th days		10th -60th days		2nd -6th month		6th -12th month		Over 2nd years		Total		
		Positive samples		Positive samples		Positive samples		Positive samples		Positive samples		Total number	Positive samples	
		N	%	n	%	n	%	n	%	n	%		%	%
Salmonella	30	0	0.0	1	3.3	4	13.3	3	10.0	2	6.7	150	10	6.7
E. coli	30	1	3.3	4	13.3	7	23.3	6	20.0	4	13.3	150	22	14.7
Staph. aureus	30	1	3.3	3	10.0	6	20.0	4	13.3	3	10.0	150	17	11.3

The data illustrated in Table 7 clarified that the most predominant serotype of Salmonella was *S. enteritides* (4 strains), followed by *S. typhimurium* (3 strains) followed by *S. anatum* and *S. muenster* (one strain of each) and finally untypable (2 strains). While, the most predominant serotype of *E. coli* was O126:K71(B16) (7 strains) followed by O86:K61(B7) (6 strains), followed by O55:K59(B5) (4 strains), O119:K69(B19) (3 strains), O111:K58(B9) (2 strains), O26:K60(B6) (one strain) and all examined water samples. Nearly similar serotypes have been previously isolated from both ostriches and poultry flocks and from their environment [15, 24, 44]. On the other hand, many researches isolated the same serotypes in addition to more serotypes [20, 35, 36]. Moreover, all isolated serotypes of *Salmonella* and *E. coli* as well as *Staphylococcus aureus* were detected previously in other species of poultry and animals, which refer to the ostrich, have not specific pathogens.

Table 7 Distribution of isolated microorganism from drinking water samples from ostrich farm (N= 210)

Isolates	Strain	n	Main source	Water tanks	Drinkers	Total n	Total %
Salmonella	S. enteritides	4	-	1	3	11	5.2
	S. typhimurium	3	-	-	3		
	S. anatum	1	-	-	1		
	S. muenster	1	-	-	1		
	Untypable	2	-	-	2		
E. Coli	O126:K71(B16)	7	1	1	5	25	11.9
	O86:K61(B7)	6	-	1	5		
	O55:K59(B5)	4	-	-	4		
	O119:K69(B19)	3	-	-	3		
	O111:K58(B9)	2	-	-	2		
	O26:K60(B6)	1	-	-	1		
	Untypable	2			2		
Staph. aureus	---------------------	18	0	1	17	18	8.6

4. CONCLUSION

From the obtained results we can conclude that both the site of water sampling and the system of housing and management (depend on the age of ostrich flock) are greatly affect the water quality. Moreover, various pathogenic strains of microorganisms were isolated from most examined water samples with a variant incidence indicating that water may act as a dangerous source of these pathogens to the ostrich flocks and consequently may act as a vehicle for human infection which constitutes a public health problem. To protect water sources from chemical and bacteriological pollutants, the following measures are suggested:

1- Strict application of law to protect River Nile and its tributaries from pollution [17].
2- Periodical chemical and physical examinations of water supply.
3- Application of strict hygienic measures in the farms to protect water in both tanks and drinkers from pollution.
4- Application of effective water sanitizers in drinking water to control microbial growth in addition to control of rodents and wild birds inside the farm.

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مجلة بنها للعلوم الطبية البيطرية عدد 23 (2) 2012 : 159-172

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بعض الدراسات الكميائية و البكتيرية على مياه الشرب بمزرعة للنعام بمحافظة الاسماعلية

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الملخص العربي

أجريت هذه الدراسة لتقييم جودة مياه الشرب بمزرعة للنعام بمنطقة القصاصين بمحافظة الاسماعلية من خلال عمل بعض تحاليل كميائية وبكتيرية ، بالإضافة إلى عزل وتصنيف بعض الميكروبات التي لها تأثير ضار على صحة الإنسان. تم تجميع عدد 210 عينة مياه (30عينة من المصدر الرئيسى، 30 عينة من خزانات المياه، 150 عينة من السقايات الخاصة بقطعان النعام فى اعمار مختلفة) خلال فصل الصيف 2011. بالتحليل الكميائى والبكتيرى لعينات المياه تبين أن أعلى متوسط لكل من الأس الهيدروجيني، الأموني، النيتريت، النترات، الفوسفات، الكلوريد، المواد العضوية، العسر الكلى و المواد الصلبة و العدد البكتيري الكلى للميكروبات الهوائية والميكروبات المعوية والميكروبات القولونية و الميكروبات المكورة العنقودية كان فى عينات المياه التى تم تجميعها من السقايات ثم العينات التى تم تجميعها من الخزانات واخيرافى العينات التى تم تجميعها من المصدر الرئيسى. و على العكس من ذلك فان اقل متوسط لكل من الأس الهيدروجيني، الأمونيا، النيتريت، النترات، الفوسفات، الكلوريد، المواد العضوية، العسر الكلى و المواد الصلبة و العدد البكتيري الكلى للميكروبات الهوائية والميكروبات المعوية والميكروبات القولونية و الميكروبات المكورة العنقودية كان فى عينات المياه التى تم تجميعها من السقايات الخاصة بقطيع النعام عند عمر 1–10يوم كم لوحظ زيادة فى جميع المتوسطات فى المياه بتقدم عمر القطيع حتى تصل اقصى معدل فى عينات المياه التى تم تجميعها من قطيع النعام عند عمر 6–12 شهر. وقد تم عزل ميكروب السالمونيلا، الميكروب القولوني و الميكروب المكور العنقودي الذهبي من المياه بنسب 5.2٪، 11.9٪، و 8.6٪. وقد خلصت النتائج الى ان كل من مكان اخذ العينة اى مصدر المياه بالاضافة الى النظام المستخدم فى التربية والرعاية (يعتمد على عمر القطيع) يؤثر بشكل كبير على جودة المياه داخل المزرعة. بالاضافة الى ان عزل بعض الميكروبات الضارة من المياه قد يؤدى الى اصابة قطعان النعام بالعديد من الامراض التى قد تصل الانسان و تسبب له العديد من المشاكل الصحية. وقد تمت مناقشه الإجراءات الواجب اتخاذها لتقليل تلوث المياه.

(مجلة بنها للعلوم الطبية البيطرية: عدد 23(2)، ديسمبر 2012: 159–172)