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EFFECT OF WATER SUPPLIES ON SOME BLOOD HEMATOLOGICAL, BIOCHEMICAL, HISTOPATHOLOGICAL PARAMETERS AND GROWTH PERFORMANCE OF FEMALE JAPANESE QUAILS.

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ABSTRACT

A total number of 90 female Japanese quails at 7 week of age were randomly distributed into three groups. Each group contains 30 birds were drank either tap (control), canal or wastewater for 4 weeks to study the influence of water supplies on some blood hematology, biochemical, growth performance and histopathological changes in liver and spleen of female Japanese quails.

The results show that the highest mean of final body weight was found in quails drinking wastewater, while, lowest mean final body weight was observed in-group of quails drinking tap water. The percentage of viability was lower in-group drinking wastewater than those drinking tap and canal water.

Hemoglobin concentration was significantly ($P< 0.05$) lower in-group treated with canal and wastewater. Glucose concenrtration in group drinking canal and wastewater were significantly ($P<0.05$) higher. The group treated by wastewater resulted in a higher incease in total plasma cholesterol & serum AST and ALT and lower concentration of plasma protein.

The highest means of carcass weight and edible parts was found in group drinking with tap and canal water, however, the lowest mean was observed in-group treated with wastewater.

Hepatic as well as splenotoxic reactions were detected mainly in case of administration with wastewater followed

by the cases canal water. While no toxic reactions could be seen in liver and spleen of birds given tap water.

In conclusion: Blood hematological, biochemical, growth performance and organs weight are all important aspects that explain water supply contamination and elimination from these quails. Histopathological lesions in both liver and spleen are indicative of damage at the tissues by the contaminates. A safe water supply is essential for healthy quails.

Key word : Japanese quail , Water supply , Blood Hematology , Biochemical , Body weight

INTRODUCTION

Water is involved in every aspect of poultry metabolism. It plays important roles in regulating body temperature, digesting food, and eliminating body wastes. At normal temperature, poultry consume at least twice as much water as feed. When heat stress occurs, water consumption will double or quadruple (Carter and Sneed, 1996).

A safe water supply is essential for healthy livestock and poultry. Contaminated water can affect growth, reproduction, and productivity of animals and poultry as well as safety of animal and poultry products for human consumption. Contaminated water supplies for livestock and poultry can also contaminate human drinking water. For these reasons, farm water supplies should be protected against contamination from bacteria, nitrates, sulfates, and pesticides (Hairston, 1995; Liu, *et al*., 1999; Hammond, 2001 and Oliveira Ribeiro *et al*., 2005).

In the arid and semi-arid regions of the world, livestock commonly use poor or marginal quality drinking water for several months of the year. The supplies originate from small wells, canals, streams or " water holes', only the better of which are also used for irrigation. Occasionally such water is high in salt, which may cause physiological upset or even death in livestock. The main reported effect is depression of appetite, which is usually caused by a water imbalance rather than related to any specific ion (Ayers and Westcot, 1994).

Therefore, the objective of the present study was: 1- to study the effect of water supplies contamination on the blood hematology, biochemical and growth performance in female Japanese quails.

2- to evaluate the pathological changes of two organs (liver and spleen) as indicator to the effect of water contamination on quails health.

MATERIALS AND METHODS

The present study was carried out at the Poultry Research Center, Faculty of Agriculture (Damanhour), Alexandria University, throughout the period of 2005. The experiment was conducted to study the influence of water supplies on blood hematology, biochemical, growth performance and histopathological changes in liver and spleen of female Japanese quails.

Sources of water: -

Tap water: This water was obtained from Water Drinking and Drainage Company - Damahour, El-Beheira, Governorate.

Canal water: Water of El-Nobareia canal is freshwater of the Nile River. The canal is supplied by water from Rosetta branch through El-Nasr canal.

Wastewater: This water was obtained from Damahour Wastewater Treatment Plant. The original wastewater is a collective product from agricultural drainage, domestic and industrial effluents from tanneries. This mixed wastewater was treated by successive treatments (preliminary, primary and secondary). The water used in this study was secondary wastewater. The water samples were taken from the surface of water according to Boyd (1979) and the water supplies were analyses (Table 1) according to standard methods (APHA, 1992).

Experimental design:

A total number of 90 female Japanese quail at 7 week of age was randomly distributed into three groups (30 birds/ Each group). The 1st group supplied with drinking tap water (control group), the 2nd group supplied with drinking canal water while 3rd group taken drinking wastewater, for 4 weeks. Quails were reared in quail' s battery cages (6 females in each cage) during 3 to 11 weeks of age. Birds were fed diet containing 20.99% crude protein with 2482.3 ME kcal/kg during 21 to 42 days of age, then changed to ration contained 20.85 crude protein with 2609 ME kcal/kg during the 6 to 11 weeks of age. The quails were given water and diets *ad-libitum* during the whole experimental period.

Studied traits:

1-Live body weight:

Live body weight of each quail was recorded at the beginning (7 week of age) and then at 11 week of age. Body weight was recorded in the morning before access to feed and water. Mortality rate was recorded daily for all water supplies along the experimental period.

2- Blood hematology:

At the end of the experimental period (11 weeks of age), Three quails from each group were randomly chosen for blood analysis. Blood sample were taken from the jugular vein of the birds in the morning. Heparin was used as an anticoagulant, but in part of the samples, it was with held to obtain serum. Plasma and serum were obtained by centrifugation of blood at 3,000 rpm for 20 minutes and then, stored at -20 oC for later analysis.

Hemoglobin concentration (Hb) was determined by the cyanomethemoglobin procedure (Eilers, 1967). Wintrobe hematocrit tubes were used for determination of packed cell volume (PCV). Blood sample were centrifuged for 20 min. at 4,000 rpm then PCV values were obtained by reading the packed cell volume on the graduated hematocrit tubes (Seiverd, 1964).

3- Blood Biochemical:

Blood glucose was carried out according to the method described by Trinder (1969). Serum total protein was measured by the Biuret method as described by Armstrong and Carr (1964). Albumin concentration was determined according to Doumas et al. (1977). Globulin concentration was calculated as the difference between total protein and albumin. Serum total cholesterol was determined according to the method of Watson (1960). Triglyceride concentration was measured by the method of Stan Bio Enzymatic triglycerides procedure using commercial kits (Stanbio). The activities of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) enzymes were assayed in serum by the method of Reitman and Frankel (1957).

4- Carcass and organs weights:

After blood samples were taken, the same birds were slaughtered, and then, dressed. Inedible parts (blood, intestine and feather) and liver, heart, spleen and gizzard were removed and weighed, individually, for the nearest 0.01 gram and dressing percentage were obtained.

5- Histopathological studies:

At the end of the experimental period (at 11 weeks of age), liver and spleen were removed after slaughting for histopathological examination. The collected tissue specimens of the liver and spleen were immediately fixed in 10 % neutral buffered formaline solution, then after washing in tap water passed through the technique of paraffin-embedding (dehydration, clearing and dealcoholization, paraffin wax embedding) and then prepared in paraffin blocks. Section of 3-5 microns thick were prepared and followed by stain with hematoxylin and eosin (Culling, 1983). Later on, stained sections were subjected to visual examination using the light microscopy .

6- Statistical analysis:

The statistical analysis of the experimental data was computed using analysis of variance procedure described in the SAS (1988). The significant differences among treatment were determined by Duncan multiple rang test (Duncan, 1955)

RESULTS

1-Growth performance:

The effect of water supply on body weight values is shown in Table 2. Initial body weight, final body weight and total weight gain were not significantly ($P<0.05$) changed with the water supplies. The highest mean of final body weight was found in quails drinking wastewater, while, lowest mean final body weight was observed in-group of quails drinking tap water. The similar trend was noticed in total weight gain.

2- Viability

Percentages of viability in quails treated with water supply are presented in Table (2). The percentage was lower in-group drinking wastewater than those drinking tap and canal water. Thus the decreasing of means in quails drinking wastewater as a percentage of tap water was 17.7%. Meanwhile, there was no differences between the tap and canal water groups.

3- Blood hematology:

Results in Table (3) showed that the effect of water supplies of female japans quails on packed cell volume (PCV) and hemoglobin content (Hb). Data revealed that blood Hb concentration was significantly (P< 0.05) lower in-group treated with canal (13.7+1.73) and wastewater (13.6+2.18) than those treated with tap water (17.3+1.88). No significant effects were observed among water supplies in PCV %.

4- Blood Biochemical:

Means of percentages of blood biochemicals are shown in Table (3). Total plasma glucose (mg/100 ml) was significantly (P<0.05) affected by water supplies. Glucose concenrtration in group drinking canal and wastewater were significantly (P<0.05) lower compard with the control group (tap water). No significant differences were observed among treatments in total plasma cholesterol, triglycerides, albumin and golbulin, but the group treated by wastewater resulted in a higher incease in total plasma cholesterol and the lower concentration of plasma protein than the other groups.

Results presented in Table (3) indicated that the treatment with canal water and wastewater resulted in a significant increase of aspartet amino transferase (AST) and alanine aminotransferase (ALT) activities compared with the tap water. The highest values for serum AST and ALT were noted in quails supplemented with wastewater. As a percentage of tap water, it was 76.34 and 126.8%, respectively.

5-Carcass traits:

Percentages of carcass traits for quails treated with water supply are summarized in Table (4). There is a significant differences in carcass, edible and inedible parts among the treatments. The highest means of carcass weight and edible parts was found in group drank with tap and canal water, however, the lowest mean was observed in-group treated with wastewater. Means percentage of liver, gizzard and heart weights for different water supplies were not significantly different from each other. Higher mean of inedible part was observed in quails treated with wastewater. Differences between the tap and canal water were not significantly in all parts.

6- Histopathological studies:

The detected microscopic changes in the liver and spleen of various treated birds were collecting and comparatively stored in table (5). The highest total store of lesions (18) was seen in birds given wastewater , followed by low score of (10) in birds given canal water than the lowest (2) or no score of lesions in birds given tap water, respectively.

The microscopic examination of the liver and spleen were studied in comparison to the normal histological parameters that were seen in the liver (fig.1) and spleen (fig.4) in case of tap water. The liver of birds given canal water was affected by mild degree of vascular degeneration of the hepatocyte with congestion and some degrees of lymphocyte aggregations (fig.2). The livers in birds given wastewater were severely affected by sever and diffuse hepatocytic vascular degeneration, congestion and lymphocyte infiltrations and aggregations (fig.3).

On regards to splenic lesions in birds given canal water thickening in the wall of follicular artenols as well as moderate degrees of dispersion of the follicular lymphocytes (fig.5) were seen. Spleen in birds given wastewater were affected by dilatation as well as thickening in the wall of the sinusoidal elements of the red pulp in addition to an excess dispersion of the lymphocytic elements of the white pulp (fig.6).

DISCUSSION

1- Growth performance

From Table 2. It can concluded that the highest body weight and weight gain in group drinking waste water attributed to water retention in quills bodies, by causing the high concentration of sodium, chloride and nitrite in waste water (Table 1).

These findings come to agreement with previous reports (Samaha and El-Bassiouny, 1991) concluded that high level of chloride in drinking water might be a cause of ascitis in chickens. Similar results were reported by Morrison et al. (1975) using a high level of sodium chloride in turkey feeding. Moreover, high concentration of chloride in drinking water of chicks may render it unpalatable for livestock and has a toxic effect (Blood and Henderson, 1974). Studies by Carter and Sneed (1996) indicate that sodium levels of 50 mg is detrimental to broiler performance f the sulfate level is also 50 mg or high and the chloride level is 14 mg or high.

On the other hand, High concentrations of nitrates in drinking-water and food are of concern because nitrate can be reduced to nitrite, causing methemoglobinemia. The hemoglobin of young children is particularly susceptible to methemoglobinemia and this, toghter with the increased ratio of water consumption to body weight, makes infants particularly vulnerable to this disease (EURO, 2004).

2- Viability

The decrease in viability in group drinking waste water my be that waste water contains many other pollutants such as animals and human wastes which contains organisms like Cryptosporidium, Giardia lamblia and Salmonella can induce symptoms ranging from sores to chest pain. E. coli, which causes diarrhea and abdominal gas. Particularly virulent strains of E. coli can cause serious illness and even death (Fulhage, 1993; Hammond, 2001; Kellog et al., 2001; Koelsch, 2001; and NRCS, 2001).

Carter and Sneed (1996) indicated the coliform bacteria are organisms normally found in the digestive tracts of livestock, humans, and birds. Their presence in water is used as a sign of fecal contamination.

EPA (2001) found that livestock and poultry are major sources of waste. Estimates indicate that the amount of livestock waste is 13 times greater than the amount of human sanitary waste. Probably the greatest health concern associated with livestock, poultry and horses wastes is pathogens. Many pathogens found in animal waste can infect humans if ingested.

3- Blood hematology:

The decrease in the concentration of Hb in quails drinking waste water (Table 3) may due to excessive amounts of nitrites. Excess nitrites are absorbed into the bloodstream. There, nitrites in the blood oxidizes the iron in hemoglobin to methemoglobin, and reduces the oxygen carrying capacity of the blood (NRC, 1974; and Hairston, 1995). Similar results were found by (EPA, 2001), they indicated that animal wastes could contribute to nitrates in drinking water. Consumption of nitrates can cause methemoglobinemia (blue baby syndrome) in infants, which reduces the ability to the blood to carry oxygen.

4- Blood Biochemical:

Plasma total glucose (mg/100ml) values for quails drink canal and wastewater were higher than of tap water (Table 3). The deleterious physiological effects of canal and wastewater have been attributed to the toxicity of cadmium (EPA, 2006).

No significant differences were observed among treatments in total plasma cholesterol, triglycerids, albumin and globulin (Table 3), but the group treated by wastewater resulted in a higher increase in total plasma cholesterol and the lower concentration of plasma protein than the other groups. EPA (2006) indicated that cadmium has the potential to cause kidney, liver, bone and blood damage from long-term exposure at levels 0.005 mg/L.

The increase of AST and ALT activities in quails treated with canal and wastewater (Table 3) may provide evidence for the occurrence of liver damage, which release more enzymes into the blood.

These results are agree with Hoffman et al. (1981). Who found that an increase in the activity of plasma alanine amino transferase (ALT) but not that of aspartate amino trasferase (AST) in lead poisoned eagles.

GOT is an enzyme present in tissues of high metabolic activity such as liver. GOT contributes to protein metabolism such as biosynthesis of amino acids. The enzyme is released into the blood circulation after the injury or cell death. GOT increases in case of liver diseases such as cirrhosis, hepatitis and hepatic necrosis as well as myocardial infarction (Fischbach, 1992 and Mc Farland and Grant, 1994).

Moreover, Henry and Milers (2001) indicated that lead affects the red blood cells (anemia and other effects on the hemopoietic system are the commonest effects) and causes damage to organs including the liver, kidneys, heart and male gonads, as well as causes effects to the immune system.

5- Carcass traits :

Quails drinking tap and canal water were increased significantly ($P<0.05$) carcass traits and edible parts by 61.5, 63.2, 67.8, and 69.6 %, respectively, when compared with the wastewater (Table 4).

From this study it can concluded that there was three probabilities: 1- the high levels of nitrate in wastewater may be decreased the digestibility and absorption of the nutrient and then decreased the carcass weight percentage. 2- the increasing dose of Pb in wastewater may be decreased the digestibility and absorption of the nutrient and then decreased the carcass weight percentage. 3- the reduction in nutrient digestibility and absorption with the high dose of microorganisms in gastrointestinal tract of quails. CES (1995) noted that high nitrate levels in water might indicate high levels of biological pathogens bacteria that can cause gastrointestinal disease. Nursita et al. (2005) reported that the accumulation of metals (cadmium, copper, lead, and zinc) in proisotoma minuta tullberg affected metabolism and reduced growth rate. In this respect, Swaileh et al. (2002) found inhibiting effects of dietary metals on growth of juvenile land snails Helix engaddensis that started to be significant from the 8th week of exposure.

6- Histopathological studies:

It was concluded that some hepatic as well as splenotoxic reactions were detected mainly in case of administration with wastewater followed by the cases canal water. While no toxic reactions could be seen in liver and spleen of birds given tap water. These results of toxic reactions in the examined organ reflecting the effect of some contents of chemical fertilizers of pesticides in the water of canal water and wastewater.

Liver is useful to describe and document the effects of pollutants (Oliveira Ribeiro et al., 2002; Bondy et al., 2003; Damek-Proprawa and Sawicka-Kapusta, 2003; Pardors et al., 2003; Akaishi et al., 2004; Brown and Steinert, 2004). Necrosis is strongly associated with oxidative stress where lipid peroxidation is a clear source of membrane bilayer susceptibility (Li et al., 2000; Avci et al., 2005). Pollutants (Heavy metals) are associated with increased free radical concentrations within the cytosol. These oxidative forms may increase programmed cell death or disturbed cell homeostasis and cellular necrosis (Stohs and Bagghi, 1995). Canli and Kalay (1998) indicated that liver and gill tissues showed higher metal concentrations (cadmium and lead) than muscle tissue of Cyprinus carpio, Barbus capito and Chondrostoma regium.

Oliveira Ribeiro et al., (2005) measure concentrations of organochlorines, polycyclic aromatic hydrocarbons and heavy metals their effects in the eel fish from three locations in the Cammargue

Reserve in southern France. They found that livers of some individuals from Mornes and Fumemorate showed different forms of preneoplasic. These foci are classically recognized as an early stage of tumor development. A rounded and nonencapsulated tumor presenting a completely differentiated and visible mass of cells was observed in liver of two individuals from Fumemorte. Differentiated and amorphous cells including numerous nuclei aware diagnostic for typical neopical neoplasic areas. Spleen had lesions that have not previously described. This organ is important for blood cell development and replacement, and is characterized by a large number of melano-macrophage and melano-macrophage centers. Necrosis and prenecrosis were observed in individuals from all studied sites. Spleen tumors, similar to those in livers, were not encapsulated and contained a large mass of differentiated cells, and within which was an active and encapsulated melano – macrophages center.

CONCLUSION

Blood hematological, biochemical, growth performance and organs weight are all important aspects that explain water supply contamination and elimination from these quails. Histopathological lesions in both liver and spleen are indicative of damage at the tissues by the contaminates. A safe water supply is essential for healthy quails.

Table 1 : Chemical composition of Tap water, Canal and Wastewater

Parameters	Tap water	Canal water	Wastewater	Drinking water quality standards for poultry[1] (Acceptable levels)
PH	7.12	7.90	7.80	6.8-8.0
TSS ppm	376	512	896	3000
Hardness mg $CaCO_3$/l	118	124	218.5	180 ppm
Calcium (Ca) mg/L	29.6	32.87	58.12	60
Magnesium (Mg) mg/L	44	46	79.07	125
Sodium mg/L	24	27	57.27	50
Potassium mg/L	5.30	6.65	17.16	
HCO_3^- mg/L	120	70.76	120.77	
Chloride mg/L	14	23.75	86.85	250
Sulpher$^-$ mg/L	43.0	54.0	94.0	250
Nitrite (NO_2) mg/L	0.00	0.020	1.15	4
Amonia(NH_3) mg/L	0.03	0.12	0.95	
Cadmium(Cd) ug/L	0.46	0.55	5.0	50
Mercury ug/L	Undetected	Undetected	Undetected	10
Cobalt ug/L	Undetected	Undetected	10	1000
Lead (Pb) ug/L	11	19	130	100
Zinc (Zn) mg/L	0.01	0.04	0.30	1.5
Manganese mg/L	0.05	0.002	0.065	
Microbiology:				
E. coli (N/ 00ml H2O)	0.0	4000	9000	50-100

[1]Adapted from Carter and Sneed, 1996; Bergsrud and Linn, 1990 and NRC, 1989.

Table 2 : Effect of water supplies on Growth performance of female japanese quails

	Tap water	Canal water	Wastewater	Prop.
Intial body weight	185.6+2.09	187.3+1.86	187.2+2.05	NS
Final body weight	204.7+3.65	218.1+4.49	221.6+6.30	NS
Total gain	19.13+3.08	30.84+4.44	34.37+4.63	NS
Viability	100.0	100.0	82.3	

NS: not significant

Table (3): Effect of water supplies on blood biochemical of female Japanese quails.

	Tap water	Canal water	Wastewater	Prop.
Hg (g/100ml)	17.3a+1.18	13.7b +1.73	13.6b + 2.18	*
Hematocrit (%)	64.0 + 2.31	61.7+ 6.64	59.0 + 2.89	NS
Glucose (mg/dl)	170.3b + 8.12	204.7ab+ 2.56	265.6a + 5.41	**
Protein (g/dl)	6.27 + 0.06a	5.08 + 0.29b	4.53+ 0.50b	*
Albumin (g/dl)	2.10 + 0.14	1.89 + 0.11	1.81+ 0.20	NS
Globulin (g/dl)	4.17 + 0.12	3.19 + 0.20	2.72 + 0.33	NS
Triglycirides (mg/dl)	374.1+ 29.9	405.6 + 11.8	470.4 + 32.1	NS
Cholesterol(mg/dl)	72.4 + 0.76	73.7+ 4.56	80.8 + 0.47	NS
AST (U/L)	39.3c + 1.88	54.1b +3.20	69.3a + 2.85	**
ALT (U/L)	22.4c + 0.60	32.1b+ 2.58	50.8a + 2.35	**

[a,b] Means with the same letter are not significantly different.
* significant at P<0.05 ** significant at P<0.05
NS: not significant

Table (4) : Effect of water supplies on carcass traits of female Japanese quails.

	Tap Water	Canal Water	Wastewater	Prop.
Carcass %	61.5+0.18a	63.2+0.53a	55.2+1.35b	**
Liver %	3.52+0.11	3.70+0.27	3.25+0.18	NS
Gizzard %	2.08+0.12	1.84+0.12	1.77+0.04	NS
Heart %	0.68+0.05	0.81+0.04	0.70+0.03	NS
Edible parts %	67.8+1.10a	69.6+0.45a	60.9+3.40b	**
Inedible parts %	32.2+0.71b	30.4+0.09b	39.1+1.23a	**

[a,b] Means with the same letter are not significantly different.
* significant at P<0.05 ** significant at P<0.05
NS: not significant.

Table (5) : scores for the microscopic changes in the examaind organs of various treated groups

Microscopic changes in the examined groups	Treated group		
	GP1	GP2	GP3
Hepatic changes Hepatocytic vaculation	-	1	3
Hepatocytic necrosis	-	1	2
Vascular congestion	-	2	3
Lymphocytic reactions	-	1	2
Splinec changes Lymphocytic dispersion	-	2	3
Lymphocytic depletion and necrosis	-	-	1
Artenolar thickening and hyperplasia	-	2	1
Sinusoidal thickening and dilatation	-	1	3
	-	10	18

GP1= quail drinking tap water
GP2= quail drinking canal water
GP3= quail drinking wastewater
- = no changes 1= mild changes
2 = moderate changes 3 = sever changes

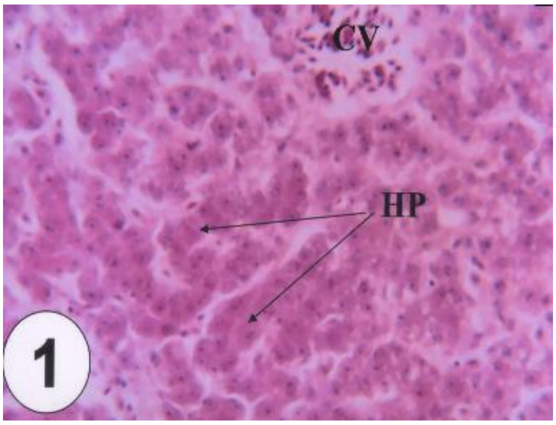

Fig.1: **Liver of control birds given tap water: showing normal hepatocytic plates (HP) and central vein (CV). H and E. x250**

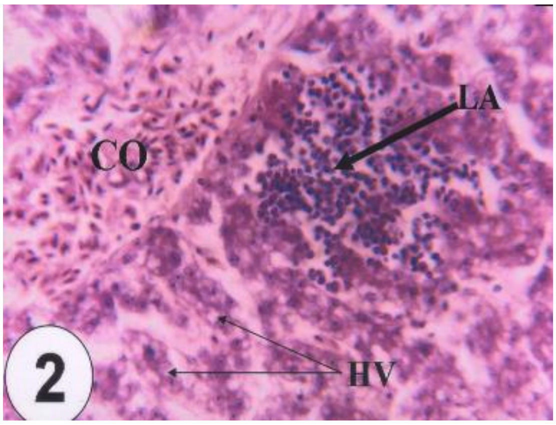

Fig.2: **Liver of birds given canal water: showing hepatocytic vascular degeneration (HV) and congestion(CO) and lymphocytec aggregations. H and E. x400**

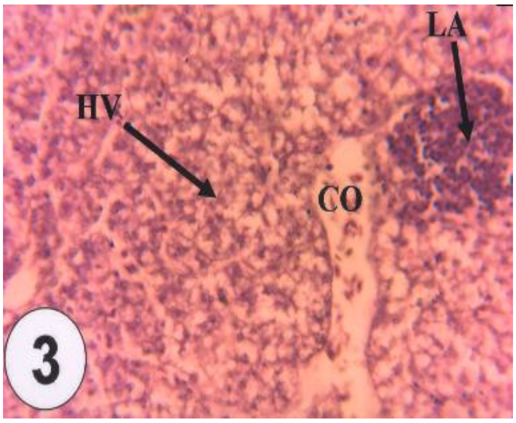

Fig.3: Liver of birds given wastewater: showing severe and diffuse hepatocytic vascular degeneration (HV) and congestion(CO) and lymphocytec aggregations . H and E .x400

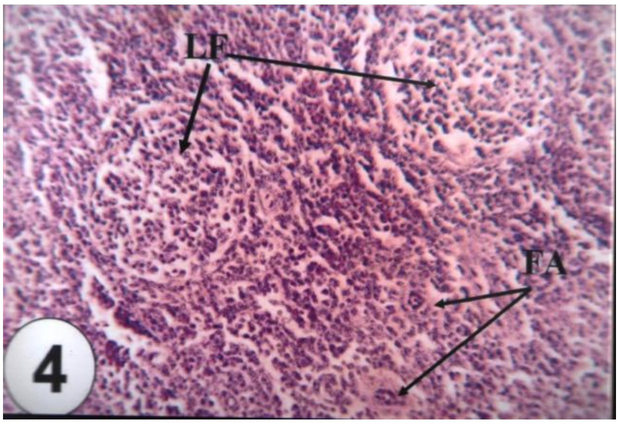

Fig.4: Spleen of control birds given tap water: showing normal histologic structure of the lymph follicles (L F), follicular artinols (FA) and sinusoids. H and E. x250

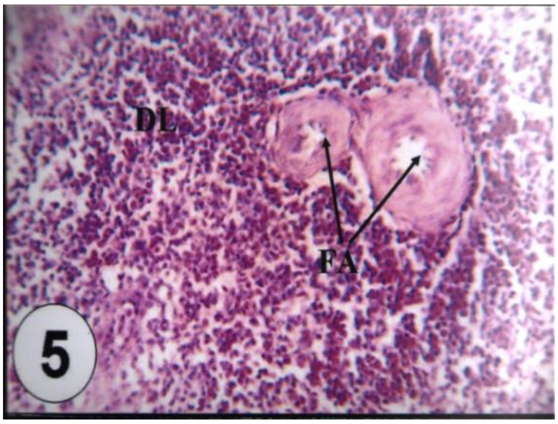

Fig.5: **Spleen of birds given canal water: showing thick wall of follicular artinols (FA) with slight dispersion of lymphocytes (DL). H and E. x250**

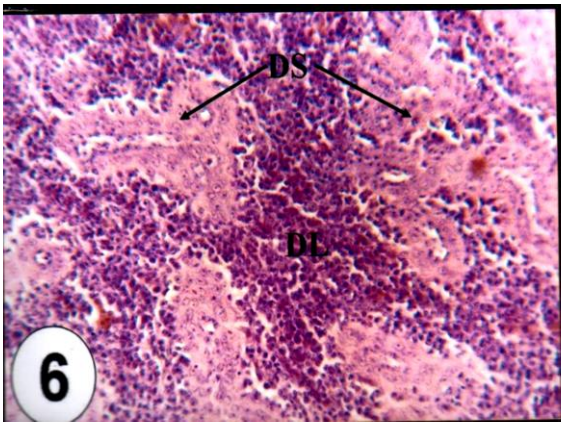

Fig.6: **Spleen of control birds given wastewater: showing dilated and thick walled of sinusoids(DS) with excess of dispersed lymphocytes. H and E. x250**

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الملخص العربى

تأثير مصادر المياه على بعض صفات الدم الفيزيقية والكيموحيوية والهستوباثولوجية وصفات النمو فى إناث السمان اليابانى

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استخدم فى هذه التجربة عدد 90 أنثى من السمان اليابانى عند عمر 7 أسابيع ، قسمت عشوائيا إلى 3 مجاميع متساوية (تحتوى كل مجموعة على 30 طائر).تناولت المجموعة الأولى ماء الصنبور (المجموعة الكنترول)، والثانية ماع الترع ، والمجموعة الثالثة ماء الصرف، وإستمرت التجربة لمدة 4 أسابيع. بهدف دراسة تأثير مصادر المياه على بعض صفات الدم الفيزيقية والكيموحيوية وصفات النمو بالإضافة إلى دراسة التغيرات الغير طبيعية لأنسجة الكبد والطحال.

أظهرت النتائج أن أعلى معدل فى وزن الجسم كان فى المجموعة التى تناولت ماء الصرف ، كما أظهرت نفس المجموعة أقل نسبة حيوية للسمان.

حدوث انخفاض معنوي في تركيز الهيموجلوبين في الدم في المجموعة التي تناولت ماء الصرف. إرتفارع تركيز السكر معنويا فى البلازما فى المجموعة التى تناولت ماء الترع أو الصرف.

أظهرت النتائج أن أعلى نسبة تركيز معنوى فى كوليسترول الدم ، ونشاط إنزيمات نقل مجموعة الأمين (ALT&AST) كان فى المجموعة التى تناولت ماء الصرف ، كما أظهرت نفس المجموعة أقل نسبة تركيز فى بروتينات الدم.

الوزن النسبى لكل من وزن الذبيحة و الأجزاء الماكولة كان مرتفعا معنويا فى المجموعة التى تناولت ماء الصنبور(الكنترول) أو ماء الترع .

أظهرت النتائج وجود تغيرات غير طبيعية فى أنسجة الكبد والطحال فى المجموعة التى تناولت ماء الصرف متمثلا فى حدوث التهابات فى خلايا الكبد وتجمع الخلايا الليمفاوية وانتشارها بكثرة حول القنوات المرارية، كذلك حدوث ورم والتهابات فى أنسجة الطحال.