

Evaluation of some heavy metals residues in batteries and deep litter rearing systems in Japanese quail meat and offal in Egypt

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Abstract

Aim: The main objectives of this study were for comparing the effect of batteries and deep litter rearing systems of domesticated Japanese quail, *Coturnix coturnix japonica*, on the concentration levels of cadmium, copper, lead, and zinc from the quail meat and offal in Ismailia, Egypt.

Materials and Methods: A total of 40 quail meat and their offal samples were randomly collected from two main quail rearing systems: Battery (Group I) and deep litter system (Group II) for determination of concentration levels of cadmium, copper, lead, and zinc. In addition, 80 water and feed samples were randomly collected from water and feeders of both systems in the Food Hygiene Laboratory, Faculty of Veterinary Medicine, Suez Canal University for heavy metals determination.

Results: The mean concentration levels of cadmium, copper, lead, and zinc in Group I were 0.010, 0.027, 1.137, and 0.516 ppm and for Group II were 0.093, 0.832, 0.601, and 1.651 ppm, respectively. The mean concentration levels of cadmium, copper, lead, and zinc in quail feed in Group I were 1.114, 1.606, 5.822, and 35.11 ppm and for Group II were 3.010, 2.576, 5.852, and 23.616 ppm, respectively. The mean concentration levels of cadmium, copper, lead, and zinc in quail meat for Group I were 0.058, 5.902, 10.244, and 290 ppm and for Group II were 0.086, 6.092, 0.136, and 1.280 ppm, respectively. The mean concentration levels of cadmium, copper, lead, and zinc for liver samples in Group I were 0.15, 8.32, 1.05, and 3.41 ppm and for Group II were 0.13, 8.88, 0.95, and 4.21 ppm, respectively. The mean concentration levels of cadmium, copper, lead, and zinc in kidney samples for the Group I were 0.24, 4.21, 1.96, and 4.03 ppm and for Group II were 0.20, 5.00, 1.56, and 3.78 ppm, respectively. Kidney had the highest concentration levels of heavy metals followed by liver then muscles. The highest concentration levels of copper were observed in liver samples. The order of the levels of these trace elements obtained from the four different quail organs is Ca > Pb > Zn > Cu. Lead and cadmium concentration levels in quail meat samples were exceeded the Egyptian standardization limits and suggesting a health threat from lead and cadmium to the quail consumers.

Conclusion: Battery rearing system is more hygienic than deep litter system from the point of heavy metals pollution of water and feeds of quail. Feed samples from battery system had means concentration levels of lead not significantly higher ($p > 0.05$) than those samples from deep litter system. Meanwhile, water samples from battery system had means concentration levels of cadmium, copper, and zinc significantly higher ($p > 0.05$) than those samples from deep litter system. Quail may carry health risks to consumers.

Keywords: batteries, deep litter, heavy metals, offal, poultry meat.

Introduction

Domesticated Japanese quail (*Coturnix coturnix japonica*) is medium-sized fowl which more eaten by Egyptians due to its low cost, rapid growth, early onset of lay, high reproduction rates, and low feed intake. Japanese quail meat is high protein content (19.6%), low-fat content (12.1 mg/100 g meat), low calorific value (192 g kcal/100 g meat), the highest amount of omega 3 fatty acids and vitamin A [1].

Increasing consumption of Japanese quail in Egypt promotes quails farms which using two rearing systems; deep litter system "Six quails can be reared in a square feet of floor space, quails transferred to cages after 2 weeks which gaining high body weight," while in battery system rearing; the space area of each unit is about one foot in width and six feet in length which subdivided into six subdivisions. Cages arranged up to six layers for saving area, each row containing about 4-5 cages. Cleaning the cage was been performed by fixation of mobile wooden plates on the bottom of the cage, feed troughs fixed in the front of cages while water troughs placed backward [2].

Heavy metals contamination is one of the major concerns worldwide, which influences the practical and structural integrity of an environment and cannot be avoid their direct and indirect effects on animal and human health. These contaminants may lift their

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residues in animal and birds tissues. In quail, heavy metals residues cannot be seen, smelled or tasted, although its amount in organs like kidney, liver is higher than muscle [3,4]. Bioaccumulation of heavy metals and their long biological half-lives in the quails consumers' bodies leading to dangerous side effects which may reach to sub-lethal or even lethal impact by long-run consumption of very low concentrations above the body requirements [5-10].

According to Duruibe *et al.* [11], cadmium, copper, lead, and zinc are toxic elements and dangerous to quail even at low concentrations when ingested over an extended period [12]. Cadmium toxic effects induced the detoxification in liver and kidney enzymes, which may lead to kidney dysfunction, hepatic injury, lung damage, and hypertension reaching to teratogenic effect [13-15]. Overdoses of copper, causes liver oxidative damage, and hepatic granular degeneration [16]. Lead poisonous has neurotoxic effect, cellular inactivation, binds to gastrointestinal enzymes, and renal systems [17-19]. Low zinc intake may lead to loss of appetite, slow healing of wounds, immunity depression, retarded growth of male sex organs while; overdose of zinc may cause abdominal cramps, vomiting, and nausea [20,21].

Domesticated quail had been rearing in Ismailia city, Egypt on battery and deep litter system for meat production. Although many researchers try to evaluate the heavy metals levels in Japanese quail meat, the available data about the trace element levels in Japanese quail at Ismailia city, Egypt are still scarce [22-24]. Therefore, this study was to determine the concentration ranges of cadmium, copper, lead, and zinc in quail meat, their offal, water and feeds from Ismailia town, reared on the each system.

Materials and Methods

Ethical approval

The Animal Rights and Ethical Use Committee of Suez Canal and Assiut Universities have approved this study.

Study area

A cross-sectional study was directed in Ismailia quails butchers to determine the concentration levels of heavy metals deposits in meat and consumable offal of quails.

Samples collection

The first part (preliminary study)

A total of 80 water and feed samples (40 each) were randomly collected equally from quails waters and feeders of battery Group I and deep litter systems (Group II). At each rearing system, each water sample (100 ml) was collected using clean tube sampler and kept refrigerated on icebox. Furthermore, each feed sample (100 g) was collected and kept in clean polyethylene bags, and then all samples were transferred into the Food Hygiene Laboratory, Faculty of Veterinary Medicine, Suez Canal University, for heavy metals determination.

Second part (main study)

A total of 60 of quail, liver and kidney samples (20 each) were randomly collected from two different locations: Markets and farms of Ismailia city. All fresh quail carcasses weighted $250 \text{ g} \pm 15$ included their liver and kidney were collected in polyethylene bags and kept in icebox then immediately transferred to the Food Hygiene Laboratory, Faculty of Veterinary Medicine, Suez Canal University, for heavy metals determination.

Samples preparation

About 25 g of each sample was well homogenized into a clean silica dish. Then, 25 ml of 20% sulfuric acid (b) was added. The sample was thoroughly mixed with a glass-stirring rod ensuring that the acid wets all material. The stirring rod was rinsed with water into silica dish. The contents of the dish were thoroughly dried on an oven at 110°C . Then, the dish was transfer into a furnace set at 25°C . The temperature was slowly raised to 500°C for about 6-8 h. The dish was removed and cooled.

Samples analysis

The digest, blank, and standard solutions were aspirated by the atomic absorption spectrophotometer [25]. Analysis was performed by Flame Atomic Absorption Spectrophotometer (VARIAN, Australia, Model AA240 FS) for determination of copper, calcium, and iron. The graphite furnace atomic absorption spectrophotometer (VARIAN, Australia, Model AA240 Z) was used for determination of lead and cadmium.

The heavy metals concentrations were calculated according to the following equation:

$$\text{Element, ppm} = R \times D \div W$$

Where, R=Reading of the digital scale of AAS,

D=Final volume of the prepared sample,

W=Weight of the sample.

Statistical analysis

Data collected were presented as mean, minimum concentration, maximum concentration, and standard error and were subjected to one-way analysis of variance. Differences between the means were tested by Duncan tests. The level of significance was chosen at $p < 0.05$ and the results are presented as mean to assess whether heavy metals varied significantly between different samples. All statistical calculations were performed with SPSS 9.0 for Windows [26].

Results

The first part (preliminary study)

Heavy metals residues in water samples

The obtained results in Table-1 revealed that the mean residual concentration levels of cadmium, copper, lead, and zinc in water samples for the Group I were 0.010, 0.027, 0.137, and 0.516 ppm and for Group II were 0.093, 0.832, 0.601, and 1.651 ppm, respectively. The water samples from battery system had means concentration levels of cadmium, copper lead, and zinc significantly higher ($p > 0.05$) than those samples from deep litter system.

The World Health Organization [27] set recommended limits to drinking water for livestock; these permissible limits are for cadmium, copper, and lead are 0.05, 0.5, and 0.2, respectively. According to these limits, the concentration levels of heavy metals in Group I were set within the permissible limit for lead and were higher for cadmium and copper residues. For water samples in Group II, the concentration levels of lead, cadmium, and copper were founded higher than the permissible limits.

Zinc was 1.651 which higher scientifically in Group II in compared to Group I. Unfortunately, there is no permissible limit or recommended guide for the concentration levels of zinc in water.

Heavy metals in feeds

The obtained results in Table-1 revealed that the mean residual concentration levels of cadmium, copper, lead, and zinc in feed samples for the Group I reared in battery system were 1.114, 1.606, 5.822, and 35.110 ppm, respectively, and for Group II reared in deep litter system were 3.010, 2.576, 5.852 and 23.616 ppm, respectively. Feed samples from battery system had means concentration levels of lead not significantly higher ($p>0.05$) than those samples from deep litter system. Meanwhile, feed samples from battery system had means concentration levels of cadmium, copper, and zinc significantly higher ($p>0.05$) than those samples from deep litter system.

Second part (main study) heavy metals in quail meat and their offal

Cadmium

The obtained results in Table-2 showed that the mean residual concentration levels cadmium in quail meat, liver, and kidney samples for the Group I samples were 0.058, 0.15, and 0.24 ppm, respectively, for Group II sample were 0.086, 0.13, and 0.20 ppm, respectively. Cadmium highly accumulated in poultry kidney then liver more than muscle [3,28-30]. Quail meat samples from markets at Ismailia city had means concentration levels of cadmium significantly higher ($p>0.05$) than farms samples.

The Egyptian Organization for Standardization and Quality Control [31] sets a permissible limit for

cadmium in poultry meat which must be not exceeding than 0.05 mg/kg. From results in Figure-1, 2 (10%) and 0 (0%) of the quail meat samples between Group I and Group II, respectively, were exceeded the permissible limit of the Egyptian standard meanwhile 18 (90%) and 20 (100%) of the samples, respectively, were within the permissible limit for cadmium.

Copper

The obtained results in Table-2 showed that the mean residual concentration levels of copper in quail meat, liver, and kidney samples for the Group I samples were 5.902, 8.32, and 4.21 ppm, respectively, while Group II samples were 6.092, 8.88, and 5.00 ppm, respectively. Copper highly accumulated in poultry liver then kidney more than muscle [32-34]. Quail meat samples from Group I at Ismailia city had means concentration levels of copper not significantly higher ($p<0.05$) than those samples from farms.

The Egyptian Organization for Standardization and Quality Control [31] sets a permissible limit for copper in poultry meat, which must be not exceeding than 15.00 mg/kg. From results in Figure-1, 20 (100%) of the samples, respectively, were within the permissible limit for copper.

Lead

The obtained results in Table-3 showed that the mean residual concentration levels lead in quail meat,

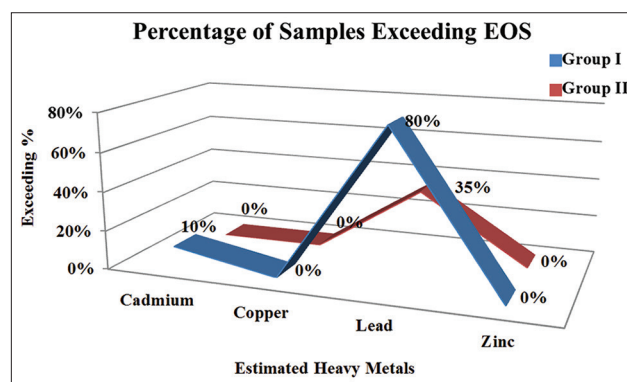


Figure-1: Frequency distribution of concentration levels of cadmium, copper, lead, and zinc in the quail meat with compared to Egyptian standard.

Table-1: Statistical analytical results of mean concentration levels of cadmium, copper, lead, and zinc in water samples and feeds samples (n=20).

| Groups | Water samples | | | | Feed samples | | |
|----------|---------------|---------|---------|---------------------------|--------------|---------|----------------------------|
| | Metals | Minimum | Maximum | Mean±SE | Minimum | Maximum | Mean±SE |
| Group I | Cadmium | 0.001 | 0.014 | 0.010 ^a ±0.002 | 0.640 | 1.320 | 1.114 ^a ±0.128 |
| | Copper | 0.014 | 0.036 | 0.027 ^a ±0.004 | 0.990 | 2.070 | 1.606 ^a ±0.174 |
| | Lead | 0.011 | 0.319 | 0.137 ^a ±0.015 | 5.340 | 6.290 | 5.822 ^a ±0.196 |
| | Zinc | 0.146 | 0.963 | 0.516 ^a ±0.134 | 30.25 | 38.90 | 35.11 ^b ±1.564 |
| Group II | Cadmium | 0.011 | 0.400 | 0.093 ^b ±0.023 | 1.940 | 3.590 | 3.010 ^b ±0.291 |
| | Copper | 0.056 | 1.348 | 0.832 ^b ±0.240 | 1.680 | 3.190 | 2.576 ^b ±0.258 |
| | Lead | 0.090 | 0.508 | 0.601 ^b ±0.038 | 5.170 | 7.210 | 5.852 ^{ab} ±0.396 |
| | Zinc | 0.241 | 5.210 | 1.651 ^b ±0.915 | 20.36 | 28.36 | 23.62 ^a ±1.345 |

Group 1: Battery system, Group 2: Deep litter system, Mean in the column has different letter is significantly difference ($p\leq0.05$). SE=Standard error

Table-2: Statistical analytical results of mean concentration levels of cadmium and copper in quail meat samples (n=20).

| Items | Cadmium | | | | | | Copper | | | | | |
|---------|--------------------------|-------------------------|-------------------------|--------------------------|--------------------------|--------------------------|--------------------------|-------------------------|-------------------------|---------------------------|--------------------------|--------------------------|
| | Group I | | | Group II | | | Group I | | | Group II | | |
| | Meat | Offal | Kidney | Meat | Offal | Kidney | Meat | Offal | Kidney | Meat | Offal | Kidney |
| Minimum | 0.010 | 0.10 | 0.12 | 0.010 | 0.09 | 0.16 | 4.300 | 2.40 | 1.89 | 3.580 | 2.55 | 1.14 |
| Maximum | 0.110 | 0.28 | 0.41 | 0.041 | 0.23 | 0.36 | 7.800 | 9.25 | 6.63 | 7.510 | 9.14 | 6.34 |
| Mean±SE | 0.058 ^a ±0.02 | 0.15 ^a ±0.02 | 0.24 ^b ±0.01 | 0.086 ^b ±0.01 | 0.13 ^{ab} ±0.01 | 0.20 ^{ab} ±0.01 | 5.902 ^a ±0.59 | 8.32 ^a ±1.80 | 4.21 ^c ±1.52 | 6.092 ^{ab} ±0.54 | 8.88 ^{ab} ±1.32 | 5.00 ^{cd} ±10.2 |

Group I: Battery system, Group II: Deep litter system, Mean in the column has different letter is significantly difference (p≤0.05). SE=Standard error

Table-3: Statistical analytical results of mean concentration levels of lead and zinc in quail meat samples (n=20).

| Items | Lead | | | | | | Zinc | | | | | |
|---------|--------------------------|-------------------------|-------------------------|--------------------------|-------------------------|--------------------------|--------------------------|-------------------------|-------------------------|--------------------------|--------------------------|--------------------------|
| | Group I | | | Group II | | | Group I | | | Group II | | |
| | Meat | Offal | Kidney | Meat | Offal | Kidney | Meat | Offal | Kidney | Meat | Offal | Kidney |
| Minimum | 0.090 | 0.84 | 0.98 | 0.070 | 0.70 | 0.90 | 1.050 | 1.66 | 1.20 | 1.110 | 2.11 | 1.90 |
| Maximum | 0.730 | 2.54 | 3.02 | 0.450 | 2.01 | 2.14 | 1.420 | 532 | 6.21 | 1.380 | 6.11 | 5.55 |
| Mean±SE | 0.244 ^a ±0.05 | 1.05 ^a ±0.08 | 1.96 ^a ±0.07 | 0.136 ^b ±0.04 | 0.95 ^b ±0.04 | 1.56 ^{cd} ±0.05 | 1.290 ^a ±0.06 | 3.41 ^b ±0.25 | 4.03 ^c ±1.01 | 1.280 ^a ±0.06 | 4.21 ^{ab} ±1.10 | 3.78 ^{cd} ±0.74 |

Group I: Battery system, Group II: Deep litter system, Mean in the column has different letter is significantly difference (p≤0.05). SE=Standard error

offal (liver and kidney) samples for the Group I were 0.244, 1.05 and 1.96 ppm, while samples of Group II from the farms were 0.136, 0.95 and 1.56 ppm, respectively. The kidney was the target organ of the lead accumulation followed by liver and muscle [3,28-30]. Meat samples from Group II at Ismailia city had means concentration levels of lead significantly higher ($p>0.05$) than those samples from Group I.

The Egyptian Organization for Standardization and Quality Control [31] sets a permissible limit for lead in poultry meat, which must be not exceeding than 0.10 mg/kg. From results in Figure-1, 16 (80%) and 7 (35%) of the quail meat samples, respectively, from Group I and Group II were exceeded the permissible limit of the Egyptian standard meanwhile 4 (20%) and 13 (65%) of the samples, respectively, were within the permissible limit for lead.

Zinc

The obtained results in Table-3 showed that the mean residual concentration levels zinc in quail meat, liver, and kidney samples for the Group I samples were 1.290, 3.41, and 4.03 ppm, respectively, for Group II samples were 1.280, 4.21, and 3.78 ppm, respectively. Quail meat samples from Group I at Ismailia city had means concentration levels of zinc not significantly higher ($p<0.05$) than Group II. Zinc highly accumulated in poultry kidney then liver more than muscle [3].

Zinc is essential nutrients for animals. Zinc used as dietary ingredients Kottferova *et al.* [35]. WHO [27] sets a permissible limit for zinc in poultry meat, which must be not exceeding than 100 mg/kg. From results in Figure-1, 20 (100%) of the two groups samples were within the permissible limit for zinc.

Discussion

The concentrations of various metals in meat are critical because these contaminants have deleterious effects on consumers. Many illnesses and diseases such as cancer and hypertension have been associated with increased concentrations of cadmium, copper, lead, and zinc in meat consumers' organs.

The first part (preliminary study) heavy metals residues in water and feeds samples

Water and feed samples from battery system had means concentration levels of lead not significantly higher ($p>0.05$) than those samples from deep litter system. Meanwhile, water and feed samples from battery system had means concentration levels of cadmium, copper, and zinc significantly higher ($p>0.05$) than those samples from deep litter system.

The obtained results clarify the presence of different heavy metals (cadmium, copper, lead, and zinc) in various levels as in Table-1. Nearly, Okoye *et al.* [36] who found about 0.038-0.463 cadmium, 6.52-14.20 copper, 1.10-7.85 lead, and 34.038-49.950 zinc in Nigeria poultry water and feeds recorded similar values. However, Raj *et al.* [37] found higher

results in India were recorded about 0.174 mg/L Cd, 0.002 mg/L Cu, 1, 0.001 mg/L Pb, and 0.011 mg/L Zn. On the other hand, Abdou *et al.* [38] noted lower levels of 0.004-0.029 ppm Cd, 0.015-0.057 ppm Cu, 0.247-0.379 ppm Pb, and 0.008-0.164 ppm Zn in other cities in Egypt drinking water, while Suganya *et al.* [39] recorded about 0.5 ppm Cd, 300 ppm Cu, 30 ppm Pb, and 1000 ppm Zn of poultry feeds in India.

It could be interpreted that heavy metals are existed in higher level in environment consequently, which may lead to bioaccumulation in water and feeds. That might attribute to water pollution, manure, and drainage system which hazard may reflect on quail production as bird consumes from 15 to 20 time's water as much as they consume feed [27]. The obtained variances were might attribute to contamination of water during slaughter with manures similar results were clarified by Maff [40] who found that heavy metal concentration at soil levels for plant.

Second part (main study) heavy metals in quail meat and their offal

Cadmium

Tissue Cd concentrations in animals are closely related to Cd levels in feedstuffs and the duration of Cd load [41]. Nutritional and vitamin status, such as iron status, age and sex and a wide range of factors controlling absorption and accumulation of Cd in tissue [42].

The obtained results came with agree with those obtained by Herzig *et al.* [43] in Czech Republic who found 4.99 ± 1.57 , 0.558 ± 0.60 , and 0.052 ± 0.008 mg/kg in liver, kidneys, and muscle, respectively. Mariam *et al.* [22] who recorded 0.3 mg/kg in Egyptian poultry meat recorded higher results of cadmium concentration levels in quail meat. However, Benouadah *et al.* [2] reported about 17.77-19.55 ug/kg in kidney, 5.45-11.79 ug/kg in liver, and 4.69-10.53 ug/kg in meat of Algerian poultry. In addition, the lower prevalence rates have recorded in other countries; 0.004-0.124 $\mu\text{g/g}$ in Iraq [42] and 0.01-5.68 mg/kg in Nigeria [23].

Cadmium is poorly absorbed in the body, but as soon as absorbed and slowly excreted, like different metals, and accumulates within the kidney causing renal harm. The kidney of food animals is a major source of cadmium in the diet even though lower degrees are located in lots of foods; cadmium is endocrine demanding substance and may cause the development of prostate and breast most cancers in addition to kidney and skeletal damage in humans [44,45].

Copper

The quantity of copper ingested, interval of exposure, animal age and breed all that are factors controlling copper accumulation in the organs [46,47]. Copper is an essential trace element that is toxic at excessive doses.

Nicolas *et al.* [29] obtained meanly similar results for copper concentration levels in quail meat

and their offal in Nigeria. Lower results of copper concentration levels in quail meat were recorded by Khan *et al.* [34], who noted 0.357, 1.35 ppm Cu in Pakistani poultry meat and liver, respectively, in Egypt Donia [3] recorded about 6.64±4.35, 3.32±3.68, and 2.84±3.68 mg/kg, (2.84-6.64) in quail liver, kidney, and meat, respectively. Akan *et al.* [6] also recorded 0.1-1.44 µg/g of in liver, kidney, and meat of chicken from Nigeria. Skalicka *et al.* [30] who found about 9.346 mg/kg and 4.822 mg/kg in liver and muscle of Japanese quails recorded higher values, respectively, in Poland; while in Malaysia, Abduljaleel *et al.* [48] reported about 24.77 and 8.6 mg/kg in the liver and quail meat, respectively.

Long exposure to copper leading to Wilson's and Menke's diseases which characterized by irritation of the eyes, nose and mouth, stomachaches, headaches, dizziness, vomiting, and diarrhea, also liver and kidney may affect. Daily recommended intake of copper is 2 mg, and as little as 10 mg of copper will have a poisonous impact [4,23,49].

Lead

Lead is one of the most toxic heavy metals having unknown biochemical benefits [3,4,30]. High residual levels of lead in quail meat samples obtained from either Group I or Group II caused by many sources such as industry. High metals levels in poultry products emanate mainly from contamination of feeds and water sources. Quail meat samples had high concentration levels of lead due to water used during quail processing for human consumption, which found be polluted with lead in different area at Ismailia city.

Skalická *et al.* [30] obtained meanly similar results for lead concentration levels in quail meat and their offal. Higher results of lead concentration levels in quail meat were recorded in Egypt by Donia [3], who reported about 1.63±0.18, 6.17±0.59, and 1.06±0.38 mg/kg in quail meat respectively [50], detected about 2.75 and 2.8 µg/g for liver and muscle from Qena and Assiut broilers, in addition, those observed by Khan *et al.* [34] in Pakistan who found about 1.234 and 1.797 mg/kg of Pb in liver and meat of *Gallus domesticus* chicken.

On the other hand, another study revealed lower results in Turkey by Uluzlu *et al.* [24] who reported 0.01-0.40 µg/g for Pb in chicken; Abduljaleel *et al.* [48] who recorded 0.55 and 0.47 mg/kg in the liver and quail muscle in Malaysia and Ghimpeteanu *et al.* [51] who noted 0.006 mg/kg Pb in poultry liver in Belgium and Romania.

The results have revealed that the lead concentration in meat is alarming and indicates the high levels of lead pollution in the environment. The major source of lead pollution is exhaust gases, which arise from agents, added in gasoline by automobile.

The poisonous consequences of lead established in studies on people exposed to lead within the course of their work. The exposure to excessive levels of

lead for a short period can cause brain harm, paralysis (lead palsy), anemia and gastrointestinal signs and symptoms, while the long exposure to lead can cause damage to the immune system, reproductive, nervous systems, and kidneys. The most dangerous effect of exposure to low lead level is on intellectual improvement in young kids; lead crosses the placental barrier and accumulates in the fetus. Thus infants and young children are greater affected than adults to the lead poisonous consequences. Even short exposures of young children to low levels of lead must take into consideration due to its effect on neurobehavioral development [52-54].

Zinc

Zinc is an essential element, playing an important role as coenzymes in the body, also needed for the tissues repairing and growth, forming connective tissues, skin, bones, teeth, hair, and nails [3,34,55,56]. Donia [3] recorded higher results of zinc concentration levels in quail meat in Egypt in quail organs were 18.9, 25.5 and 9.82 mg/kg in liver, kidney and quail muscle respectively [30], in Slovak recorded 25.5 mg/kg and 8.11 in kidney and quail muscle. Abduljaleel *et al.* [48] in Malaysia reported in Japanese quails about 50.607 and 51.076 mg/kg in liver and muscle. On the other hand, lower results obtained in Iraq by Reem *et al.* [42] who found about 3.266 mg/kg Zn from poultry liver.

Zinc added to poultry diets to improve immunity, weight gain. Zinc toxicity leading to pneumonia mortality in children [57].

Conclusion

The results of this work indicated the heavy metals concentrations in Domesticated Japanese quail; *C. coturnix japonica* quail were statistically significant from two main quail rearing systems: Battery (Group I) and deep litter system (Group II) for determination of concentration levels of cadmium, copper, lead, and zinc. The order of the levels of these trace elements obtained from the four different quail organs is Cd > Pb > Zn > Cu. Kidney had the highest concentration levels of heavy metals followed by liver then muscles for Cd, Pb and Zn, but the highest concentration levels of copper were observed in liver samples. Lead and cadmium concentration levels in quail meat samples were exceeded the Egyptian standardization limits and suggesting a health threat from lead and cadmium to the quail consumers. Battery rearing system is more hygienic than deep litter system from the point of heavy metals pollution of water and feeds of quail. Feed samples from battery system had means concentration levels of lead not significantly higher than those samples from deep litter system. Meanwhile, water samples from battery system had means concentration levels of cadmium, copper, and zinc significantly higher than those samples from deep litter system. We recommend the battery rearing

system in quail farms and decrease the heavy metals pollution of water and feeds of quail.

Authors' Contributions

AMA and DMH designed the experiments, study and performed the experiments; NTE interpreted the data and wrote the manuscript. All authors read and approved the final manuscript.

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Competing Interests

The authors declare that they have no competing interests.

References

- Priti, M. and Satish, S. (2014) Quail farming: An introduction. *Int. J. Life Sci.*, 2(2): 190-193.
- Benouadah, A., Diafat, A. and Djellout, B. (2015) Assessment of trace heavy metals contents of chicken from Algeria. *Int. J. Plant Anim. Environ. Sci.*, 5(2): 45-50.
- Donia, G.R. (2015) Determination of some heavy elements residues in some organs of migratory Quail in relation to public health. *Int. J. Sci. Res. IJSR*, 4(10): 2048-2059.
- Khalafalla, F.A., Abdel-Atty, N.S., Abd-El-Wahab, M.A., Ali, O.I., Rofaida, B., Abo-Abduljaleel, S.A., Shuhaimi-Othman, M. and Babji, A. (2012) Assessment of trace metals contents in chicken (*Gallus gallus domesticus*) and Quail (*Coturnix coturnix japonica*) tissues from Selangor. *J. Environ. Sci. Technol.*, 5(6): 441-451.
- Burger, J., Veitch, C.R. and Gochfeld, M. (1994) Locational differences in metal concentrations in feathers of Australasian gannet (*Morus serrator*) in New Zealand. *Environ. Monit. Assess.*, 32: 47-57.
- Akan, J.C., Abdulrahman, F.I., Sodipo, O.A. and Chiroma, Y.A. (2010) Distribution of heavy metals in the liver, kidney and meat of beef, mutton, caprine and chicken from Kasuwan Shanu market in Maiduguri metropolis, Borno State, Nigeria. *Res. J. Appl. Sci. Eng. Technol.*, 2(8): 743-748.
- SCAN. (2003) Scientific Committee on Animal Nutrition: Opinion of the Undesirable Substances in Feed. Adopted on 20 February 2003, updated on 25 April 2003. Available from: http://www.europa.eu.int/comm/food/fs/sc/scan/out126_bis_en.pdf. Accessed on 24-11-2016.
- Jarup, L. (2003) Hazards of heavy metal contamination. *Br. Med. Bull.*, 68: 167-182.
- Sathawara, N.G., Parikh, D.J. and Agarwal, Y.K. (2004) Essential heavy metals in environmental samples from western India. *Bull. Environ. Contam. Toxicol.*, 73: 264-269.
- Gupta, U.C. and Gupta, S.C. (1998) Trace elements toxicity relationships to crop production and livestock and human health: Implication for management. *Commun. Soil Sci. Plant Anal.*, 29: 1491-1522.
- Duruibe, J.O., Oguwuegbu, M.O.C. and Egwurugwu, J.N. (2007) Heavy metal pollution and human bio toxic effects. *Int. J. Phys. Sci.*, 2(5): 112-118.
- Young, R.A. (2005) Toxicity Profiles: Toxicity Summary for Cadmium, Risk Assessment Information System, RAIS, University of Tennessee. Available from: <http://www.rais.ornl.gov/tox/profiles/cadmium.shtml>, Accessed on 20-06-2016.
- John, H.H. and Jeanne, I.R. (1994) Food additives, contaminants and natural toxins. In: Maurice, E.S., James, A.O., Moshe, S.L. and Febiger, M. P. editors. *Modern Nutrition in Health and Disease. Part. II.* 8th ed. Lea & Febiger, Malvern, Pennsylvania. p1597-1598.
- Reddy, A.T.V. and Yellamma, K. (1996) Cadmium chloride induced alteration in the detoxification enzymes of rat liver and kidney. *Pollut. Res.*, 15: 371-373.
- Dong, Z., Wang, L., Xu, J., Li, Y., Zhang, Y., Zhang, S. and Miao, J. (2009) Promotion of autophagy and inhibition of apoptosis by low concentrations of cadmium in vascular endothelial cells. *Toxicol. In Vitro*, 23(1): 105-110.
- Emin, O.O., Hayati, Y., Yasar, E., Cevik, T.A. and Gunfer, T. (2010) The effects of copper sulfate on liver histology and biochemical parameters of term ross broiler chicks. *Biol. Trace Elem. Res.*, 133: 335-341.
- Cunningham, W.P. and Saigo, B.W. (1997) *Environmental Science a Global Concern.* 4th ed. WMC Brown Publisher, New York. p389.
- Baykov, B.D., Stoyanov, M.P. and Gugova, M.L. (1996) Cadmium and lead bioaccumulation in male chickens for high food concentrations. *Toxicol. Environ. Chem.*, 54: 155-159.
- ATSDR. (2007) Toxicological Profile for Lead. US Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Atlanta, GA. Available from: <http://www.atsdr.cdc.gov>. Accessed on 18-06-2016.
- ATSDR. (2004) Division of Toxicology. Agency for Toxic Substances and Disease Registry, Atlanta, GA. Available from: <http://www.atsdr.cdc.gov/toxprofiles/>, Last accessed on 21-07-2016.
- Argonne National Laboratory, Environmental Science Division (EVS), Human Health Fact Sheet. (2005). Available from: <http://www.ead.anl.gov/pub/doc/zinc.pdf>, Accessed on 24-11-2016.
- Mariam, I., Iqbal, S. and Nagra, S.A. (2004) Distribution of some trace and macro minerals in beef, mutton and poultry. *Int. J. Agric. Biol.*, 6: 816-820.
- Iwcbuc, C.M.A., Nwajei, G.E. and Iyoha, E.H. (2008) Heavy metal residues of chicken meat and gizzard and Turkey meat consumed in Southern Nigeria. *Bulg. J. Vet. Med.*, 11(4): 275-280.
- Uluozlu, O.D., Tuzen, M., Mendil, D. and Soylak, M. (2009) Assessment of trace element contents of chicken products from Turkey. *Hazard. Mater.*, 163: 982-987.
- Germis, A.C. and Stenzenberg, H. (1978) Estimating calcium in mechanically deboned poultry meat by oxidimetry and atomic absorption spectrophotometry. *Food Chem.*, 3(3): 213-219.
- Ozdamar, K. (1991) *Biostatistics with SPSS.* Kann Press, Eskisehir. p2-23.
- WHO. (2011) Cadmium. Environmental Health Criteria 134. World Health Organisation, International Programme on Chemical Safety (IPCS), Geneva, Switzerland.
- Zhuang, J., Liu, Y., Wu, Z., Sun, Y. and Lin, L. (2009) Hydrolysis of wheat straw hemicellulose and detoxification of the hydrolysate for xylitol production. *BioResources*, 4(2): 674-686.
- Nicolas, O., Osuji, L.C. and Onwuachu, U.I. (2012) Estimation of dietary intake of cadmium, lead, manganese, zinc and nickel due to consumption of chicken meat by inhabitants of Port-Harcourt metropolis, Nigeria. *Arch. Appl. Sci. Res.*, 4(1): 675-684.
- Skalicka, M., Korenekova, B. and Nad, P. (2008) Distribution of trace elements in liver and muscle of Japanese Quails. *Slovak J. Anim. Sci.*, 41(4): 187-189.
- EOS. (2010) Egyptian Organization for Standardization and Quality Control. Maximum Level for Certain Contaminants in Food Stuffs. ES No. 7136/2010.
- Jevsnik, M. and Doganoc, D.Z. (2003) Trace elements in Slovenian poultry tissues. *J. Food Prot.*, 66: 686-690.
- Magali, L., Andre, J.M., Bernadet, M.D., Gontier, K.,

- Gerard, G. and Davail, S. (2008) Concentrations of metals (Zn, Cu, Cd, Hg) in three domestic ducks in France: Pekin, Muscovy and Mule ducks. *J. Agric. Food Chem.*, 56: 281-288.
34. Khan, M.Z., Perween, S.H., Gabol, K., Khan, I.S. and Baig, N. (2015) Concentrations of heavy metals in liver, meat and blood of poultry chicken *Gallus domesticus* in three selected cities of Pakistan. *Can. J. Pure Appl. Sci.*, 9(1): 3313-3324.
35. Kottferova, J., Korenekova, B. and Skalicka, M. (2002) Zinc levels in poultry meat. *Trace Elem. Electrolytes*, 19: 91-93.
36. Okoye, C.O.B., Ibeto, C.N. and Ihedioha, J.N. (2011) Assessment of heavy metals in chicken feeds sold in South Eastern, Nigeria. Pelagia research library. *Adv. Appl. Sci. Res.*, 2(3): 63-68. Available from: <http://www.pelagiaresearchlibrary.com>. Accessed on 28-05-2016.
37. Raj, J., Raina, A., Mohinees, A. and Dogra, D. (2013) Direct Determination of Zinc, Cadmium, Lead, Copper Metal in Tap Water of Delhi (India) by Anodic Stripping Voltammetry Technique. E3S Web of Conferences. Available from: <http://www.e3s-conferences.org> or <http://www.dx.doi.org/10.1051/e3sconf/20130109009>. Accessed on 23-04-2016.
38. Abdou, K.A., Khadiga, I.A., Mahmoud, A.S. and Housen, M.S. (2016) Distributions of metals (Cadmium, Lead, Iron, Manganese, Zinc and Copper) in water, aquatic plant and fish in the river Nile. *Chem. Res. J.*, 1(3): 43-56.
39. Suganya, T., Senthikumar, S., Deepa, K., Muralidh, J., Sasikumar, P. and Muthusamy, N. (2016) Metal toxicosis in poultry - A review article. *Int. J. Sci. Environ. Technol.*, 5(2): 515-524.
40. Maff, L. (1994) Fertilizer Recommendations for Agricultural and Horticultural Crops. Reference Book 209. HMSO, London.
41. Torra, M., To-Figueras, J., Rodamilans, M., Brunet, J. and Corbella, J. (1995) Cadmium and zinc relationships in liver and kidney of humans exposed to environmental cadmium. *Sci. Total Environ.*, 170: 53-57.
42. Reem, T.H., Hussain, M., Ebraheem, K.H. and Hanady, M. (2012) Assessment of heavy metals (Cd, Pb and Zn) contents in livers of chicken available in the local markets of Basrah city, IRAQ. *Basrah J. Vet. Res.*, 11(1): 43-51.
43. Herzig, I., Narratiloru, M., Suchy, P., Vecerek, V. and Totusek, J. (2007) Model trial investigating retention in selected tissues using broiler chicken fed cadmium and humic acid. *Vet. Med.*, 52(4): 162-168.
44. Nordberg, G., Jin, T., Bernard, A., Fierens, S., Buchet, J.P. and Ye, T. (2002) Low bone density and renal dysfunction following environmental cadmium exposure in China. *Ambio*, 31: 478-481.
45. Saha, N. and Zaman, M.R. (2012) Evaluation of possible health risks of heavy metals by consumption of foodstuffs available in the central market of Rajshahi city, Bangladesh. *Environ. Monit. Assess.*, 185: 3867-3878.
46. Nkansah, A.M. and Anisah, J.K. (2014) Determination of Cd, Hg, As, Cr and Pb levels in meat from the Kumasi Central Abattoir. *Int. J. Sci. Res. Publ.*, 4(8): 2250-3153.
47. Youssef, A.I. and Mansour, D.H. (2014) Potential role of migratory Quail in spreading of some zoonotic pathogens in Egypt. *Am. J. Anim. Vet. Sci.*, 9(4): 203-210.
48. Abduljaleel, S.A., Shuhaimi-Othman, M. and Babj, A. (2012) Assessment of trace metals contents in chicken (*Gallus gallus domesticus*) and Quail (*Coturnix coturnix japonica*) tissues from Selangor (Malaysia). *J. Environ. Sci. Technol.*, 5: 441-451.
49. WHO, (World Health Organization). (1996) Trace Elements in Human Nutrition and Health. WHO, Geneva. p76-141.
50. Mahmoud, M. and Abdel-Mohsein, H. (2015) Health risk assessment of heavy metals for Egyptian population via consumption of poultry edibles. *Adv. Anim. Vet. Sci.*, 3(1): 58-70.
51. Ghimpeteanu, O.M., Das, K., Militaru, M. and Scippo, M.L. (2012) Assessment of heavy metals and mineral nutrients in poultry liver using inductively coupled plasma- Mass spectrometer (ICP-MS) and direct mercury analyzer (DMA). *Bull. UASMV Vet. Med.*, 69(1-2): 285-266.
52. Canfield, R.L., Henderson, C.R.Jr., Cory-Slechta, D.A., Cox, C., Jusko, T.A. and Lanphear, B.P. (2003) Intellectual impairment in children with blood lead concentrations below 10 microg perdeciliter. *N. Engl. J. Med.*, 348(16): 1517-1526.
53. Trampel, D.W., Imerman, P.M., Carson, T.L., Kinker, J.A. and Ensley, S.M. (2003) Lead contamination of chicken eggs and tissues from a small farm flock. *J. Vet. Diagn. Invest.*, 15: 418-422.
54. Zaheer Khan, M., Shahnaz P., Karim G., Iqbal, S., Nadeem, B., Roohi, K. and Tanveer, J. (2015) Concentrations of heavy metals in liver, meat and blood of poultry chicken *Gallus domesticus* in three selected cities of Pakistan. *Can. J. Pure. Appl. Sci.*, 9(1): 3313-3324.
55. Soetan, K.O., Olaiya, C.O. and Oyewole, O.E. (2010) The importance of mineral elements for humans, domestic animals and plants: A review. *Afr. J. Food Sci.*, 4(5): 200-222.
56. Mineral Information Institute. (2012) The Role of Elements in Life Processes: Minerals, Elements and Nutrition. Available from: <http://www.mii.org/periodic/lifeelement.html>. Accessed on 15-04-2012.
57. Hala, S.H., Mohamed, H. and Shireen, M.N. (2009) Estimation of some heavy metals in chicken. *Egypt. J. Comp. Pathol. Clin. Pathol.*, 22(3): 24-36.
