BENHA UNIVERSITY
FACULTY OF VETERINARY MEDICINE
BENHA VETERINARY MEDICAL JOURNAL

HAZARD EVALUATION OF SOME INSECTICIDES AND HEAVY METALS RESIDUES IN DUCK CARCASSES

Dalia F. khater [a], Hanaa M. Soultan [b], Nadia A. Abosrea [b]

[a] *Food Hygiene Dept., Tanta lab., Animal Health Research Institute*, [b] Food Hygiene Dept., Animal Health Research Institute

A B S T R A C T

The present study was designed to determine some heavy metals and insecticide residues in duck carcasses obtained from retail markets of Berma and Tanta, Gharbia governorate, Egypt. Forty samples of meat, liver, gizzard and heart (10 of each) were collected for determination of heavy metals (lead and cadmium) and insecticide (aldrin, dieldrin and malathion) residues. Lead and cadmium was recovered from all samples of duck meat, heart, gizzard and livers. Significant differences ($P<0.05$) of lead and cadmium levels were observed between duck meat, heart, gizzard and liver samples. Moreover, > 80% and > 90% of examined samples for lead residues and >70% and >90% of examined samples contained cadmium residues were found to exceed the limits recommended by E.O.S.Q.C. and FAO/WHO. In contrary, malathion concentrations were low, and within international statutory safe limit (0.02 ppm). The mean values of malathion levels estimated for duck meat, heart, gizzard and liver samples were 0.84, 0.89, 0.94 and 1.15 (ppb), respectively. It was surprising that aldrin and deldrin were not detected from all examined duck samples. It is concluded, duck meats and offal contained higher levels of heavy metals compared to insecticides which were generally low, and within international statutory safe limits. The information provided herein should receive more attention from the point of public health, for residue control in meat and edible offal in Egypt, helping the implementation and maintenance of sanitary control.

KEY WORDS: Aldrin, Cadmium, Dieldrin, Duck Carcasses, Lead, Malathion.

(BVMJ 22(2): 87-94, 2011**)**

1. I N T R O D U C T I O N

Food is usually the main source of human exposure to heavy metals for human being. After prolonged evaluation studies on food additives and their toxicity, the WHO has come to the conclusion that even low levels of some metals, such as lead and cadmium, can cause disease in human [47, 48]. Contamination of food with heavy metals is a serious threat because of their toxicity, bioaccumulation and biomagnifications in the food chain [14]. Lead, for example, bio-accumulates in plants and animals. Its concentration is generally magnified in the food chain [29]. Cadmium has a long residence time in human tissues (10–40 years.

In recent years, much attention has been focused on the levels of heavy metals in domestic animals, fish and other seafoods with little attention on the levels of heavy metals in poultry meats and edible tissues.

Lead is of public health concern due to several hazardous effects which may affect many organs and systems of the body (CNS, blood, kidney, genital system and Immune system) with carcinogenic effect and high level of intoxication may result in attacks of abdominal pain until coma and death [12]. Cadmium is one of the most toxic metals, it might cause renal and pulmonary dysfunction, bone and liver damage. In Brazil, the program of residue control in products of animal origin of the Ministry of Agriculture was established [42].

On the second axis, the growing global volume of chemicals currently use has raised concerns about their long-term effects on health and the environment. In the last decade, many international agreements have focused on a group of chemical substances known as persistent organic pollutants (POPs). Organophosphorus pesticides (OPPs), less persistent than organochlorine (OCPs), are frequently the preferred choice for treatment because they provide efficacious, safe and cost effective control of a wide range of pests. The awareness that OPPs may also concentrate along the food chain has led to the establishment of low maximum residue limits (MRLs) in meat, as set by European Union (UE). Consequently, this makes necessary for the control of this type of compounds in fatty matrices [13. 11]. These compounds (OCPs and OPPs) are known of inducing or aggravating certain health problems in humans such as cancer, immune systems suppression and the disruption of hormonal functions [45]. Because malathion is one of the most frequently detected pesticides in the FDA’s Total Diet Studies, there is a great potential for exposure of the general population to malathion by consumption of food containing residues of the chemical.

On the other hand, organochlorine residues have been found in the tissues and eggs of many species of birds in Europe and North America. It has been assumed that most of these insecticide residues came from both plant and animal feed ingested by the birds. While it is established that concentrations of pesticides often increase through the food chains, the degree of concentration is variable.

In Egypt, poultry meat and offal are major sources of protein to the human population and are widely consumed. In fact, there are very little or no available original data on content of these chemical residues and contaminants in poultry tissues in Egypt, therefore this study was applied in order to determine the levels of lead and cadmium, as well as, residual limits of malathion (organophosphorus pesticides), aldrin and dieldrin (organochlorine) in meat and edible offal of duck carcasses at local retail markets of Gharbia governorate, Egypt, with emphasis on hygienic and toxicological aspects.

2. MATERIAL AND METHODS

2.1. Sampling:

Forty samples of meat, liver, gizzard and heart (10 of each) obtained from freshly slaughtered duck carcasses were collected from retail markets of Berma and Tanta, Gharbia governorate, and transferred without undue delay in an ice box to the National Research Centre for determination of heavy metals and insecticides residues.

2.2. Determination of heavy metals:

The samples were digested according to the technique described by Perez (39). Levels of lead (Pb) and cadmium (cd) in each digest were determined by using Atomic Absorption Spectrophotometry, with the blank solution set as zero (0) and the standards used for calibration of the spectrophotometer "AAS"(Perkin Elmer, 2380, USA) which was adjusted at 217 and 22808 for lead and cadmium, respectively.

2.3. Determination of Aldrin, Dieldrin and Malathion residues:

They were conducted by using HPLC apparatus (ISCO, model 2350) and 205 UV/vis detectors with Hypersil HPLC column 250 x 4.6mm BDs 180C 5M

Samples were extracted and the pesticide residues were determined according to

A.O.A.C. (6) and Pesticide Analytical Manual (PAM) (40)

3. RESULTS AND DISCUSION

In Egypt ducks are free grazing and drink water from ditches, streams, rivers and other possible contaminated water sources. They graze along runways and other sites that might have been contaminated with toxic substances. Ducks also could be liable to exposure to high levels of contaminants in the environment. These pollutants accumulate in the organs and other tissues.

In the present study, lead residues were recovered in tissues of all duck samples. The mean levels of lead estimated for duck meat, heart, gizzard and liver samples were 0.261, 0.264, 0.269 and 0.471 ppm, respectively. Nearly similar results were reported in muscles and liver of slaughtered broilers [31]. High lead residual levels were recorded in muscles and livers of broilers [2, 3, 34, 38]. Lower results were present in Spain [26] where the mean concentrations of lead and cadmium were 6.94 and 1.68 ug.kg^{-1} in chicken meat. Moreover, a recent study [27], in southern Nigeria, recorded that Pb concentrations were varied between 0.01-4.60 mg/kg for chicken meat, 0.01-3.22/ mg/kg for gizzards and 0.08-1.55 mg/kg for turkey meat. The current data showed significant differences ($P < 0.05$) in Pb concentrations between duck meat, heart, gizzard and liver samples (Table, 1). Moreover, the highest level of lead was found in liver samples. Several studies in different animal species and poultry showed that lead concentrates were more in the livers than in meat and other organs [21, 28, 31]. Furthermore, highly elevated concentrations of Pb were detected in the livers of ducks harvested by hunters in the Illinois River, New Jersey and Connecticut [5, 25, 32]. According to E.O.S.Q.C. [17], 80%, 90 %, 100 % and 100 % of duck meat, heart, gizzard and liver samples exceeded the permissible limits of Pb concentrations, moreover, 90 %, 90 %, 100 and100% of duck meat, heart gizzard and liver samples exceeded the permissible limits of Pb concentrations according to FAO/WHO [19] as shown in table (2).

Lead can adversely affect many organs and systems leading to numerous conditions such as high pressure, anemia, kidney damage, impaired wearing, metal retardation and shortened gestation period in women [46], while young children are considered at great risk because of their ability to effectively absorb lead and thereby suffer mental and physical development retardation [33].

Analytical data in the present study indicated that cadmium was recovered from all samples of duck carcasses. The mean levels of cadmium estimated for duck meat, heart, gizzard and liver samples were 0.20, 0.307, 0.316 and 0.368 ppm, respectively, The results showed also differences in lead levels ($P < 0.01$) between duck meat, heart, gizzard and liver samples (Table 1). A review study in birds [34] revealed similar observations. Moreover, nearly similar results were reported in Egypt [2, 31] in muscles and liver of slaughtered broilers. Meanwhile, lower results were reported in Nubaria area [1] where the mean concentration of cadmium was 1.2 ppm in chicken meat.

Table 1 Lead and Cadmium concentration in meat and edible offal of freshly slaughtered duck carcasses.

	Min.	Max.	Heavy metal concentration (ppm)
Lead			
muscle	0.0 3	0.30	0.26±0.009 ^{c}
heart	0.01	0.30	0.26±0.008 ^{c}
gizzard	0.24	0.31	0.27±0.009 ^{b}
liver	0.42	0.51	0.47±0.010 ^{a}
Cadmium			
muscle	0.07	0.34	0.20±0.007 ^{d}
heart	0.09	0.34	0.31±0.005 ^{c}
gizzard	0.30	0.36	0.32±0.007 ^{b}
liver	0.34	0.42	0.37±0.009 ^{a}

$^{a-d}$ Values (Mean ± SE, n=10) in the same column bearing different letters are significantly different (P<0.05).

Table (2) Acceptability of duck meat and edible offal samples (n=10) based on their levels of lead and cadmium according to E.O.S.Q.C. (2005) and FAO/WHO (1992)

Tissue	Reference	Maximum permissible limits (ppm)	No of unacceptable samples for Pb level	%	No of unacceptable samples for Cd level	%
Muscle						
	E.O.S.Q.C.	0.1	8	80	8	80
	FAO/WHO	0.05	9	90	9	90
Heart						
	E.O.S.Q.C.	0.1	9	90	9	90
	FAO/WHO	0.05	9	90	9	90
Gizzard						
	E.O.S.Q.C.	0.1	10	100	10	100
	FAO/WHO	0.05	10	100	10	100
Liver						
	E.O.S.Q.C.	0.1	10	100	10	100
	FAO/WHO	0.05	10	100	10	100

Table (3): Malathion concentration (ppb) in meat and edible offal of duck carcasses (n =10).

Tissue	Number of positive samples	Range	Mean ± SE	Reference	Maximum permissible limit (ppm)	No of acceptable sample	%
Muscle	7	0.90-1.40	0.84 ± 0.19^{b}	FAO/WHO	0.02	7	70
Heart	7	1.00-1.51	0.889 ± 0.22^{b}	FAO/WHO	0.02	7	70
Gizzer	7	1.15-1.60	0.94 ± 0.20^{b}	FAO/WHO	0.02	7	70
Liver	7	1.33-1.81	1.15 ± 0.25^{ab}	FAO/WHO	0.02	7	70

$^{a-d}$ Values in the same column bearing different letters are significantly different (P<0.05).

Furthermore, in Lahore [38] the Cd content was determined as 0.31 mg/kg for meat of poultry. On the other hand, high cadmium residual levels were detected in chicken meat [3, 26, 34]. Moreover, Cd concentrations in kidney and liver tissues of Mallards duck were well below levels associated with sublethal effects in duck in previous studies [8, 15, 16].

Table (2) revealed that according to E.O.S.Q.C. [17] 70%, 90 %,100 % and 100 % duck meat, heart, gizzard and liver samples were exceeding the permissible limits of cadmium concentrations, respectively, meanwhile 90 %, 90 %,100 and100% of duck meat, heart gizzard and liver samples were exceeding the permissible limits of cadmium concentrations, respectively, according to FAO/WHO [19]. Previous study [32] investigated that Cd concentrations were elevated in 99% of American woodcock livers and kidneys. Detectable concentrations of Cd and Pb were present in in 87%, and in 86% of muscle samples analyzed.

Cadmium toxicity affects many target tissues such as brain, heart, blood vessels, kidney and lungs. This toxicity may cause anemia, dry and scaly skin, emphysema, fatigue, hair loss, heart disease, depressed immune system response, hypertension, joint pain, kidney stones or damage, liver dysfunction or damage, loss of sense of smell, lung cancer, pain in the back and legs, and yellow teeth in human [33].

On contrary to the results of Pb and Cd the present study indicated that Aldrin & Deldrin were not detected from all duck samples examined. Similar results were reported in chicken [30] collected from markets located in Luxor city. Meanwhile, our results disagree with a previous study [36] where dieldrin was detected in avian broiler fat and in 28% of fresh poultry sausage.

In the current study, malathion was recovered from 7 samples of duck carcasses. The mean levels of malathion residues estimated for duck meat, heart, gizzard and liver samples were 0.842, 0.889, 0.937 and 1.15 (ppb), respectively. Furthermore, our data indicated also that all examined duck samples in this study were within permissible limits (0.02 ppm) according to FAO/WHO [20] (Table 3). Nearly similar concentration were reported in Egypt [30] where malathion concentration in frozen chicken were ranged from 0.8 to1.2 ppb with mean value of 0.95. Higher results were recorded by FSIS National Residue Program [23] who found that malathion concentration in poultry meat were 4 ppm. Monitoring studies have been conducted to determine the presence of malathion residues in/on food and feeds. Malathion was not found in any of 655 samples of tested poultry meat [41]. In contrary, malathion were present at 0.05 – >2.0 ppm, in 249 out of the 19,851 samples of food and animal feeds tested by the FDA in fiscal years 1982–1986, the selection of test samples was not random, but was geared toward choosing samples most likely to contain pesticide residues based on various factors [37]. Malathion belongs to the group of very effective organophosphorous pesticides. They can be found in the environment and food chain due to their wide usage in agriculture [9]. The metabolism and toxicology of these compounds in mammals have been intensively studied and reviewed [9, 35, 44]. Organophosphorous pesticides are potent inhibitors of acetylcholinesterase [9]. Moreover, they also inhibit the other enzyme which plays an important role in a great number of biochemical processes [10].

It is concluded that there is wide variation in heavy metal contents and insecticides residues in duck carcasses of Berma and Tanta regions. In general, duck meats and offal contained higher levels of metals (Pb and Cd) compared to insecticides which were generally low, and within international statutory safe limits. These levels of trace elements in samples could result from contamination of the feed, water source and the environment. Therefore people that consume duck meat in these areas are likely to be exposed to higher metal levels. The information provided herein should receive more attention from the point of public health, for residue control in meat and meat products in Egypt, helping the implementation and maintenance of sanitary control.

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تقييم الخطورة لتواجد بقايا المبيدات الحشرية والمعادن الثقيلة فى ذبائح البط

داليا فتحى خاطر[1]، هناء محمود سلطان[2]، نادية عبد الفتاح أبو سريع[2]
[1]قسم صحة الأغذية – معمل طنطا – معهد بحوث صحة الحيوان، [2] قسم صحة الأغذية – معهد بحوث صحة الحيوان

الملخص العربى

أجريت هذه الدراسة لتحديد بقايا بعض المعادن الثقيلة و المبيدات الحشرية فى لحوم والأحشاء الداخلية لذبائح البط المجمعة من أسواق برما وطنطا بمحافظة الغربية – مصر, حيث تم تجميع أربعين عينة من اللحوم والقلب والقونصة والكبد الخاصة بذبائح البط (10 لكل منهما) لفحص بقايا المعادن الثقيلة (الرصاص والكادميوم) وبعض المبيدات الحشرية (الدرين، ديلدرين ومالاثيون). أظهرت النتائج التحليلية إكتشاف بقابا معادن الرصاص والكدميوم فى جميع عينات للحوم البط والقلب والقونصة والكبد حيث كانت متوسط مستويات الرصاص 0.261، 0.264، 0.269 و 0.471 جزء في المليون كما كانت متوسط مستويات الكادميوم 0.3، 0.307، 0.316 و0.368 جزء في المليون على التوالي، أظهرت التحليلات الإحصائية اختلافات جوهرية (ف <.050) لمستويات الرصاص والكادميوم بين عينات اللحوم و عينات الأعضاء الأخرى. ووفقا للحدود المسموح بها لبقايا الرصاص والكادميوم المذكورة بالموصفات المصرية القياسية و الفاو – منظمة الصحة العالمية أفادت النتائج أن أكثر من 80 ٪ و90 ٪، من العينات المفحوصة تجاوزت الحدود المسموح بها من تركيزات الرصاص،و أن أكثر من 70 ٪ و90 ٪ من العينات كانت غير امنة بالنسبة لبقايا الكادميوم ، وعلى العكس كانت تركيزات الملاثيون فى الانسجة المختلفة منخفضة ومطابقة للحدود الامنة العالمية (0.02 جزء في المليون) حيث كان متوسط مستويات مخلفات مالاثيون المقدرة للحوم البط والقلب والقونصة والكبد 0.842، 0.889، 0.937 و1.15 (جزء من البليون) على التوالي. ومن المدهش أنه لم يتم اكتشاف بقايا الألدرين وديالدرين فى جميع العينات التى تم فحصها. وقد خلصت الدراسة عن وجود إختلافات كبيرة بين مستويات بقايا المعادن الثقيلة والمبيدات الحشرية فى ذبائح البط بمنطقتى برما وطنطا وعموما فإن لحوم والأحشاء الاخلية للبط إحتوت لاعلى مستويات مرتفعة من بقاياالمعادن مفارنة بالمبيدات الحشرية والتى كانت منخفضة ومطابقة للحدود الامنة. وقد أفادت هذه المعلومات عن توجيه اهتمام أكبر من الناحية الصحية للتخلص من هذه البقايا فى الحوم ومنتجاتها بمصر.

(مجلة بنها للعلوم الطبية البيطرية: عدد 22 (2)، ديسمبر 2011: 87-94)