POLISH JOURNAL OF NATURAL SCIENCES
Abbrev.: Pol. J. Natur. Sc., Vol 25(3): 244–251, Y. 2010

DOI 10.2478/v10020-010-0022-x

CHLORINATED HYDROCARBONS IN FEED AND TISSUES OF TURKEY HENS FROM A BREEDING FLOCK AND THEIR CONTENT IN EGG YOLKS AND BLOOD OF POULTS

***Andrzej Faruga*[1], *Renata Pietrzak-Fiećko*[2], *Stefan S. Smoczyński*[1]**

[1] Department of Poultry Breeding
[2] Department of Commodities and Food Analysis
University of Warmia and Mazury in Olsztyn

K e y w o r d s: turkeys, DDT, blood, egg yolk, yolk sack, abdominal fat.

A b s t r a c t

The aim of the study was to determine the content of chlorinated hydrocarbons (DDT, DDE, DDD and γ-HCH) in different tissues of turkeys from a reproductive flock. Linear correlation coefficients between the contents of chlorinated hydrocarbons in blood of the turkey hens and their concentrations in egg yolks; in egg yolk and their concentrations in blood of poults; in egg yolk and their concentrations in yolk sack of poults, in blood of the turkey hens and their concentrations in abdominal fat of the hens were determinated. Significant correlations were determined only between the contents of chlorinated carbohydrates in blood and their concentration in egg yolks of the layers. The contents of chlorinated hydrocarbons in the research material did not arouse serious hygienic and toxicological concerns.

CHLOROWANE WĘGLOWODORY W PASZY I TKANKACH INDYCZEK STADA REPRODUKCYJNEGO ORAZ ICH ZAWARTOŚĆ W ŻÓŁTKACH JAJ I KRWI PISKLĄT

***Andrzej Faruga*[1], *Renata Pietrzak-Fiećko*[2], *Stefan S. Smoczyński*[1]**

[1] Katedra Drobiarstwa
[2] Katedra Towaroznawstwa i Badań Żywności
Uniwersytet Warmińsko-Mazurski w Olsztynie

S ł o w a k l u c z o w e: indyki, DDT, krew, żółtka jaj, woreczek żółtkowy, tłuszcz sadełkowy.

Address: Stefan S. Smoczyński, University of Warmia and Mazury, pl. Cieszyński 1, 10-719 Olsztyn, Poland, phone, +48 (89) 523 39 74, e-mail: stesmo@uwm.edu.pl

Abstract

Celem badań było określenie zawartości chlorowanych węglowodorów (DDT, DDE, DDD i γ-HCH) w różnych tkankach indyczych stada reprodukcyjnego. Określono liniową korelację między zawartością chlorowanych węglowodorów w krwi indyczek a ich zawartością w żółtkach jaj; między zawartością chlorowanych węglowodorów w żółtkach jaj a ich zawartością w krwi piskląt; między zawartością chlorowanych węglowodorów w żółtkach jaj a ich zawartością woreczkach żółtkowych piskląt; między zawartością w krwi a zawartością w tłuszczu sadełkowym indyczek. Stwierdzono istotne korelacje tylko między zawartością chlorowanych węglowodorów w krwi indyczek a ich zawartością w żółtkach jaj. Zawartości chlorowanych węglowodorów w badanym materiale nie budzą zastrzeżeń higienicznych i toksykologicznych.

Introduction

Recent studies have found that chlorinated carbohydrates and their derivatives still occur in the environment and in food. Circulating in the environment, they are subject to bioaccumulation in particular links of the food chain. In Poland, preparations containing DDT have been withdrawn from use since 1976, yet they are still used in some countries of Asia and Africa for fighting insects that transfer malaria as well as in crops of tobacco and cotton, DDT was used in the East Germany for forest spraying until the 1980s. By penetrating into atmosphere, this compound is adsorbed onto molecules of liquids suspended in it and in that form may be transferred for long distances (STRUCIŃSKI et al. 2000).

Organic chlorine hydrocarbons are a group of xenobiotics with special toxicological significance which, due to considerable stability in the environment and lipophilic character, pose a high risk to the health of humans and animals. This compounds affects the marrow and morphological elements of blood as well as the immunological and nervous systems. Methyl sulfone metabolites of DDT exert a toxic effect on adrenal glands bringing about death of the cells. The DDT influences also the hormonal system causing spontaneous miscarriages, anomalies in the reproductive systems, and shortening of lactation period in mammals (STRUCIŃSKI et al. 2000. VIDAEFF and SEVER 2005).

Presence of organochlorine hydrocarbons has been reported, among others, in animal milk (JUSZKIEWICZ and NIEWIADOWSKA 1984, PIETRZAK-FIEĆKO et al. 2000), tissues of slaughter animals (FARUGA et al. 2008b, NIEWIADOWSKA et al. 1995, 2008. ULRICH and RASZYK 2002) and game (JANICKI et al. 2007, RODZIEWICZ and HAJDUK 1995) as well as hen eggs (AURIGI et al. 2000. NIEWIADOWSKA et al. 1996, SMOCZYŃSKI et al. 1979). Blood as a liquid tissue of a live organism serves an important physiological function. Its multi-oriented role may be fulfilled only without the occurrence of extrinsic factors that make it impossible. Extrinsic substances often determined in human

blood include chlorinated hydrocarbons (SYROWATKA et al. 1981). Many studies have also addressed the content of chlorinated hydrocarbons in the blood of slaughter animals (AMAROWICZ et al. 1987. SMOCZYŃSKI et al. 1984). Their concentration in blood may indicate contamination of other body tissues. Studies carried out on birds (GLICK 1974) demonstrated that DDT affected a decrease in blood level of immunoglobulins G and M. Results of experiments carried out on hens (ADAMCZYK 1971) also point to translocation of DDT through blood from adipose tissue to muscles. Data on the content of chlorinated hydrocarbons in blood and eggs of domestic fowls may also be useful in breeding, especially in its intensive form.

The aim of the study was to determine the content of chlorinated hydrocarbons (DDT, DDE, DDD and γ-HCH) in different tissues of turkeys from a reproductive flock and linear correlation coefficients between the contents of these compounds in blood of the turkey hens and their concentrations in egg yolks; in egg yolk and their concentrations in blood of poults; in egg yolk and their concentrations in yolk sack of poults, in blood of the turkey hens and their concentrations in abdominal fat.

Material and Methods

Experiments were carried out on 50 turkey hens (BUT-5) kept in individual cages. All layers were provided equal and optimal environmental conditions. Over the entire laying period, the turkey hens were fed *ad libitum* a complete mixture. They were inseminated every 7th day with semen diluted at a ratio of 1:1. Eggs for hatching were collected 6 times a day, stored for a period of 7 days and incubated in Petersime incubators. During incubation, the hatching of poults was monitored. In addition, in the 3–4, 11–12 and 19–20 week of the laying season, blood and 2 eggs were collected from each layer, and the contents of γ-HCH, DDE, DDD and DDT were assayed in whole blood and egg yolk lipids. The content of chlorinated carbohydrates was also determined in the complete mixture, abdominal fat of turkey hens after the reproductive period as well as in blood and yolk sacks of one-day-old poults. Chlorinated hydrocarbons from the complete mixture, abdominal fat of hens, egg yolks and yolk sacks were isolated according to the method described by AMAROWICZ et al. (1986), and those from blood of turkey hens and poults – according to SYROWATKA et al. (1979). Separation and quantitative determination of chlorinated hydrocarbons were conducted by means of gas chromatography using a PU 4600 chromatograph by UNICAM with an electron capture detector and a glass column (2.1 x 4 mm) filled with Supercoport 100/120 covered with a liquid phase of 1.5% SP-2250 + 1.95%

SP-2401. The temperature of the detector was 250°C, the injector was 225°C and the column was 195°C. Argon was used as a carrier gas at a flow rate of 60 cm^3/min.

Identification was carried out by comparing retention times of peaks in a standard mixture and experimental sample. Quantitative calculations were performed by means of Unicam 4880 software. To provide the quality of results and control of the methods applied, samples of reference material were also analyzed. In addition, linear correlations were computed between the contents of chlorinated hydrocarbons in the samples examined.

Results and Discussion

During 20 weeks of the laying season, all birds displayed good welfare and high reproductivity. The mean number of eggs obtained from one layer was 114, the weight of eggs was 84.6 g and the brooding of poults from fertilized eggs was 90.05%.

Table 1 presents the mean values and variability coefficients of the contents of chlorinated carbohydrates in the complete mixture, blood of turkey hens and poults, egg yolk, yolk sack and the abdominal fat of the hens. In the feed mixture, the content of γ-HCH (0.0128 ng g^{-1}) was higher than that of DDT (0.0001 ng g^{-1}). Analyses also demonstrated a higher concentration of DDT metabolites (DDE-0.0117 ng g^{-1}. DDD-0.0155 ng g^{-1}) than DDT itself. whose content reached as little as 0.0001 ng g^{-1}. The total content of DDT and its metabolites in the feed mixture was low and accounted for 0.0273 ng g^{-1}. The content of HCH in blood of turkey hens (0.0002 ng g^{-1}) was lower than that in blood of one-day-old poults (0.0013 ng g^{-1}). Contrary results were reported for the content of DDT, a higher concentration of which was noted in blood of turkey hens (0.0021 ng g^{-1}) than in the blood of the poults (0.0001 ng g^{-1}). In addition, the blood of the hens was found to contain a higher concentration of DDT than of its metabolites: DDE 2-fold and DDD 5-fold. An opposite tendency was demonstrated in the blood of the poults, in which the concentration of DDT (0.0001 ng g^{-1}) was lower than that of its metabolites (DDE-0.0028 ng g^{-1}. DDD-0.0003 ng g^{-1}).

Low percentage contribution of DDT in Σ DDT and high contribution of metabolites of DDT: DDE (to 42.8%) and DDD (to 56.8%) in complete mixture testifies that they are not introduced to environment at present. High percentage contribution of DDT in blood of turkey hens (55.3%) and abdominal fat of the hens (84.7%) can showed that DDT is able to accumulate in tissues of organism. Very low (amount subliminal) levels of DDT don't activate of defensive mechanism and facilitate accumulation in organism.

Table 1

Contents of chlorinated carbohydrates in the research material (ng g^{-1})

Chlorinated carbohydrates	Statistical measures	Complete mixture $n=30$	Blood of turkey hens $n=50$	Egg yolk $n=100$	Abdominal fat of the hens $n=50$	Blood of poults $n=50$	Yolk sack of poults $n=50$
γ-HCH	x	0.0128	0.0002	0.0149	0.0012	0.0013	0.0354
	SD	0.003	0.0001	0.009	0.0003	0.0007	0.021
	range	0.010– –0.015	0.000– –0.0003	0.0056– –0.024	0.0008– –0.0015	0.0006– –0.0019	0.014– –0.059
	v	19.98	80.47	62.40	28.32	50.43	60.56
DDE	x	0.0117	0.0013	0.0068	0.0076	0.0028	0.0174
	SD	0.005	0.0015	0.0029	0.0018	0.0024	0.0114
	range	0.007– –0.0167	0.000– –0.0028	0.0039– –0.0097	0.0058– –0.0094	0.0004– –0.0052	0.006– –0.0288
	v	42.31	115.09	43.16	23.41	86.86	65.38
	%	42.8	34.2	41.5	13.4	87.5	32.4
DDD	x	0.0155	0.0004	0.0063	0.0011	0.0003	0.0321
	SD	0.0129	0.0013	0.0029	0.0005	0.0007	0.0767
	range	0.0025– –0.0285	0.000– –0.0017	0.0034– –0.0093	0.0006– –0.0016	0.000– –0.0009	0.000– –0.1087
	v	83.75	325.47	47.04	42.17	219.45	238.87
	%	56.8	10.5	37.5	1.9	9.4	59.6
DDT	x	0.0001	0.0021	0.0037	0.0481	0.0001	0.0043
	SD	0.0001	0.0136	0.0056	0.0157	0.0006	0.0089
	range	0.000– –0.0002	0.000– –0.0156	0.000– –0.0094	0.0324– –0.0638	0.000– –0.0007	0.000– –0.0132
	v	141.42	646.06	152.8	32.74	587.31	206.12
	%	0.4	55.3	21.0	84.7	3.1	8.0
Σ DDT	x	0.0273	0.0038	0.0168	0.0568	0.0032	0.0536
	SD	0.0079	0.0156	0.0081	0.0162	0.0027	0.0773
	range	0.0194– –0.0353	0.000– –0.0194	0.0086– –0.0249	0.0406– –0.0731	0.0005– –0.0059	0.000– –0.1309
	v	29.12	410.00	48.46	28.60	84.81	144.24

x – mean values. v – variability coefficients (%), % – percentage contribution of DDT metabolites in Σ DDT

Linear correlation coefficients between the contents of chlorinated hydrocarbons in blood of the turkey hens and their concentrations in egg yolks (Table 2), ranged from –0.036 to +0.654 and in the case of DDD (+0.534). DDT (+0.549) and sum of DDT (+0.654) were statistically significant ($p < 0.05$, 0.01), which may suggest that the transport of these compounds proceeds via the circulatory system to other organs. The coefficients of correlation obtained between contents of chlorinated hydrocarbons in the egg yolk of turkey hens and blood of poults (Table 2) were statistically insignificant (ranged from –0.216 to +0.020). However, the coefficient of correlation computed for DDE of –0.400 was close to being significant. In turn, no correlation was calculated for the content of DDT since it occurred only in a few blood samples.

The coefficient of correlation computed between the contents of chlorinated carbohydrates in egg yolk and yolk sacks (Table 2) fluctuated between –0.042 and 0.442 and in all cases was statistically insignificant, which is difficult to explain and requires further investigations. It should be emphasized that the correlation coefficient calculated for γ-HCH was close to being significant. No statistically significant coefficients of correlation were determined between the contents of chlorinated hydrocarbons in the blood and abdominal fat of turkey hens, in contrast to the correlation between their concentrations in blood and egg yolks of the hens (Table 2).

Table 2

Linear correlation coefficients between the contents of chlorinated hydrocarbons in selected materials

Specification		Blood of turkey hens				
		γ-HCH	DDE	DDD	DDT	Σ DDT
Egg yolk	γ-HCH	0.193				
	DDE		–0.036			
	DDD			0.534*		
	DDT				0.549*	
	Σ DDT					0.654**
		egg yolk				
		γ-HCH	DDE	DDD	DDT	Σ DDT
Blood of poults	γ-HCH	–0.216				
	DDE		–0.400			
	DDD			0.020		
	DDT				X	
	Σ DDT					–0.038
		egg yolk				
		γ-HCH	DDE	DDD	DDT	Σ DDT
Yolk sack of poults	γ-HCH	0.442				
	DDE		0.324			
	DDD			0.144		
	DDT				–0.042	
	Σ DDT					0.247
		blood of the turkey hens				
		γ-HCH	DDE	DDD	DDT	Σ DDT
Abdominal fat of the hens	γ-HCH	0.213				
	DDE		–0.039			
	DDD			–0.115		
	DDT				0.048	
	Σ DDT					0.004

Explanation: *$p < 0.05$; **$p < 0.01$; X – inanalysable value

No statistically significant coefficients of correlation between the contents of chlorinated hydrocarbons in the turkey blood and egg yolk lipids and number of laid eggs, weight of eggs and hatchability from fertile eggs were

determined in our earlier research (FARUGA et al. 2008a). Content of chlorinated hydrocarbons (DDT) in blood of turkey was ranged 0.0009–0.0081 ng g^{-1} however in turkey egg lipids was higher 0.0122–0.0210 ng g^{-1} (FARUGA et al. 2008a).

Aulakh et al. determined 0.91 mg kg^{-1} Σ DDT in feed while in chicken muscle – 0.24 mg kg^{-1} and that higher residues were in eggs (0.51 mg kg^{-1}) compared to muscle (AULAKH et al. 2006).

Furusawa research indicate that in fats from tissues of laying hens and eggs yolk DDT and DDE were transferred throughout the tissues and egg yolk while DDD was detected only in the liver after oral administration single dose of p.p'-(DDT) – 1 mg kg^{-1} body weight (FURUSAWA 2002).

Conclusions

The contents of chlorinated hydrocarbons in the samples examined were small and did not arouse serious hygienic or toxicological concerns. Significant correlations were determined only between the contents of chlorinated carbohydrates in blood and egg yolks of the layers. The low coefficients of correlation computed between contents of chlorinated hydrocarbons in egg yolks and their concentrations in the blood and yolk sacks of the poults as well as between their contents in blood and abdominal fat of the hens. The explanation the way of transportation of the chlorinated hydrocarbons from the blood of turkey hens to other tissues and from egg yolks to tissues of the poults requires further investigations.

Translated by JOANNA JENSEN

Accepted for print 3.08.2010

References

AULAKH R.S., GILL J.P.S., BEDI J.S., SHARMA J.K., JOIA B.S., OCKERMAN H.W. 2006. *Organochlorine pesticide residues in poultry feed, chicken muscle and eggs at poultry farm in Punjab, India*. J Sci. Food Agric., 86: 741–744.

AURIGI S., FOCARDI S., HULEA D., RENZONI A. 2000. *Organochlorine contamination in bird's eggs from the Danube Delta*. Environ, Pollution, 109: 61–67.

ADAMCZYK E. 1971. *The translocation the DDT in the hens' organism under influence of hunger*, Med. Wet., 27: 103–105.

AMAROWICZ R., SMOCZYŃSKI S., BOREJSZO Z. 1986. *A rapid method of isolation of chlorinated hydrocarbons from fat*, Rocz. PZH. 37: 542–545.

AMAROWICZ R., SMOCZYŃSKI S., FARUGA A. 1987. *Chlorinated hydrocarbons in the blood of living organisms*. III. *DDT and its metabolites in the blood of ducks fed barley from different levels of nitrogen fertilization*. Acta Acad. Agricult. Techn. Olst. Techno. Alim., 21: 81–89.

FARUGA A., PUDYSZAK K., BOREJSZO Z., SMOCZYŃSKI S., PIETRZAK-FIEĆKO R. 2008a. *Concentration of chlorinated hydrocarbons in turkey hens' blood and egg yolk compared to thier reproductivity traits*. Med. Wet., 64: 1401–1403.

FARUGA A., PUDYSZAK K., BOREJSZO Z., SMOCZYŃSKI S.S., PIETRZAK-FIEĆKO R. 2008b. *Studies on the effect of chlorinated hydrocarbons content in the compound animal feeding stuffs on the residues in turkey carcasses and result of slaughter turkeys rearing*. Pol. J. Vet. Sci., 11: 213–218.

FURUSAWA N. 2002. *Transferring and distributing profiles of p,p'-(DDT) in eggs-forming tissues and eggs of laying hens following a single oral administration*. J. Vet. Med. A. 49: 334–336.

GLICK B. 1974. *Antibody-mediated immunity in the presence of mirex and DDT*. Poult. Sci., 53: 1476–1485.

JANICKI B., BOREJSZO Z., SMOCZYŃSKI S., SUMCZYŃSKI P., OLSZEWSKA K. 2007. *Chloroorganic insecticides in the fatty tissue and liver of free-living pheasants*. Med. Wet., 63: 481–483.

JUSZKIEWICZ T., NIEWIADOWSKA A. 1984. *Residues of pesticides and polychlorinated biphenyls in animal tissues, milk, eggs and environment in the light of 15-years of the own studies*. Med. Wet., 40: 323–327.

NIEWIADOWSKA A., ŻMUDZKI J., SEMENIUK S. 1995. *Contamination of hens by chlorinated hydrocarbon residues*. Med. Wet., 51: 346–348.

NIEWIADOWSKA A., ŻMUDZKI J., SEMENIUK S. 1996. *Residues of organochlorine pesticides and polichlorinated biphenyls (PCB) in the hen eggs*. Bromat. Chem. Toksykol., 29: 79–84.

NIEWIADOWSKA A., SEMENIUK S., ŻMUDZKI J. 2008. *Pesticide residues in food of animal origin in 1997-2006 in Poland*. Med. Wet., 64: 1221–1224.

PIETRZAK-FIEĆKO R., TOMCZYŃSKI R., SMOCZYŃSKI S. 2000. *Residues of chlorinated carbohydrates in animal and human milk*. Med. Wet., 56: 715–717.

RODZIEWICZ L., HAJDUK A. 1995. *Residues of chloroorganic pesticides in the fat of game from Eastern Poland in 1990-1993*. Med. Wet., 51: 199–200.

SMOCZYŃSKI S., MARKIEWICZ K., FARUGA A., TYWOŃCZUK J. 1979. *DDT, DDE, DDD and HCH in spare fat and egg yolk of hen fed with different fodders*. Zesz. Nauk. ART. Olsztyn Technol. Żywn., 15: 195–202.

SMOCZYŃSKI S., AMAROWICZ R., FARUGA A. 1984. *Chlorinated hydrocarbons in the blood of living organisms*. II. *DDT, DDE, DDD and HCH in the blood of fattened ducks*. Zesz. Nauk. ART Olsztyn Technol. Żywn., 20: 183–188.

STRUCIŃSKI P., LUDWICKI J.K., GÓRALCZYK K., CZAJA K. 2000. *Endocrine disrupting action of persistent organochlorine compounds – an overview*. Roczn. PZH. 51: 211–228.

SYROWATKA T., GÓRSKI D., PALUT D. 1981. *Residue of hydrocarbons in blood of residents of Warsaw and precincts the in IV quarter 1979*. Rocz. PZH, 32: 267–272.

ULRICH R., RASZYK J. 2002. *Variations in environmental contamination by polychlorinated biphenyls (PCB) and chlorinated pesticides (Lindane, DDT) on pig farms in Hodonin district in 1994 to 1999*. Vet. Med. – Czech. 47: 159–168.

VIDAEFF A.C., SEVER L.E. 2005. *In utero exposure to environmental estrogens and male reproductive health: a systematic review of biological and epidemiologic evidence*. Reprod. Toxicol., 20: 5–20.