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Concentration of chlorinated hydrocarbons in turkey hens' blood and egg yolk compared to their reproductivity traits

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Summary

The growing demand for turkey meat causes an intensification of studies on factors that determine the reproductive performance of these birds. Results of numerous studies indicate that extremely stable chlorinated hydrocarbons negatively affect the reproductivity of animals. It therefore seems reasonable to perform studies on the content of DDT, DDE, DDD and γ-HCH in the blood and egg yolk of turkeys as well on its effect on the reproductive performance of these birds. The analyzed compounds were found both in the blood and egg yolk of laying hens. Their content, however, did not influence the reproductivity, egg laying and weight, as well as hatching results. The studies should therefore be continued.

Keywords: DDT, blood, egg yolk, turkey hens, reproductivity traits

The increasing demand for food resulting from rising population growth and crop losses caused by pests require the application of better and more modern pesticides. One of the commonly used insecticides in agriculture was DDT. Extremely extensive use of that efficient and inexpensive pesticide caused widespread environmental contamination with its residues and main metabolites: DDE and DDD. The investigations that have been carried out for many years indicate that different concentrations of chlorinated hydrocarbons are still found in the environment. High concentrations of DDT and its metabolites are not found in the air, water and soil; however DDT concentrations in the soil are vary considerably depending on the geographic area, climate, industrialization and intensity of DDT use. In water these compounds are hardly soluble; however under strong adsorption in water molecules, DDT concentrations may repeatedly exceed the solubility limits (6, 9, 18). Research demonstrates that DDT and its derivatives probably participate in the disturbance of biochemical processes in animal organisms, including the induction of neoplastic processes (7, 21). DDT has been reported to affect the functioning of hormonal systems, which has especially prompted the monitoring of these compounds both in the environment and in animal bodies (1, 13, 20, 23).

The main route of the DDT absorption is the alimentary tract. As other polychlorinated aromatic hydrocarbons, this compound is able to accumulate in the adipose tissues of animals (3, 8, 12, 15, 19). That feature, resulting in good solubility in fats, enables the penetration of high amounts of that compound into the egg yolk (11, 16, 17). The results of investigations performed on hens (2) prove the phenomenon of DDT translocation into muscles through the blood of adipose tissues.

Taking into account growing demand for turkey meat as well as the fact that chlorinated hydrocarbons are still found in the environment and in different products, it seems justified to perform studies on their content in turkeys and their effect on turkeys' reproductive performance.

Material and methods

The experiment was performed on 50 turkey hens (BUT-5) kept in individual cages. All laying hens were kept in the same, optimal environmental conditions. Through-

Tab. 1. Content of chlorinated hydrocarbons in blood of turkey (ng/g) ($\bar{x} \pm s$; v%)

Chlorinated hydrocarbons	Period of laying in weeks		
	3-4	11-12	19-20
γ-HCH	0.0002 0.0002 76.41	0.0003 0.0002 69.77	0.0001 0 0
DDE	0.0026 0.0016 60.71	0.0007 0.0003 49.38	0.0006 0.0013 231.06
DDD	0.0001 0.0004 362.17	0.0003 0.0003 118.60	0.0007 0.0020 312.29
DDT	0.0000 0.0000 0.00	0.0000 0.0000 0.00	0.0069 0.0246 355.35
DDE + DDD + DDT	0.0027 0.0017 65.26	0.0009 0.0005 50.32	0.0081 0.0279 343.21

Tab. 2. Content of chlorinated hydrocarbons in turkey egg lipids (ng/g) ($\bar{x} \pm s$; v%)

Chlorinated hydrocarbons	Period of laying in weeks		
	3-4	11-12	19-20
γ-HCH	0.0146 0.0054 36.68	0.0084 0.0021 24.82	0.0269 0.0112 41.55
DDE	0.0074 0.0021 27.95	0.0080 0.0028 35.29	0.0033 0.0016 49.10
DDD	0.0069 0.0037 52.99	0.0066 0.0017 25.67	0.0045 0.0026 58.56
DDT	0.0067 0.0067 100.47	0.0001 0.0000 0.00	0.0044 0.0051 115.35
DDE + DDD + DDT	0.0210 0.0101 47.97	0.0148 0.0036 24.07	0.0122 0.0058 47.50

out the laying period, the hens were fed *ad libitum* a full-ration fodder mixture. 7-day intervals the hens were inseminated with diluted semen (1 : 1). The eggs were collected for hatching 6 times a day and stored for 7 days, then they were incubated in Petersime incubators. During incubation, the hatchability of the chick was monitored. In 3-4, 11-12, and 19-20 weeks of the laying period, blood samples and 2 eggs were collected from each laying hen.

In full blood and egg yolk lipids the following compounds were determined: γ-HCH (gamma-Hexachlorocyclohexane); p,p'-DDE [1,1-dichloro-2,2-bis(4-chlorophenyl)ethylene]; p,p'-DDD [1,1-dichloro-2,2-bis(4-chlorophenyl)ethane] and p,p'-DDT [1,1,1-trichloro-2,2-bis(2-chlorophenyl-4-chlorophenyl)-ethane]. Chlorinated hydrocarbons were isolated from the egg yolks by the method described by Amarowicz et al., (4), and from blood samples – according to Syrowatka et al. (22). Separation and quantitative determination of chlorinated hydrocarbons were performed by gas chromatography on a PU 4600 chromatograph coupled with an electron capture detector (ECD) and glass column (2.1 × 4 mm) packed with Supelcoport 100/120 covered with liquid phase 1.5% SP-2250 + 1.95% SP-2401. Temperatures of the detector, injector and column were 250°C and 195°C respectively. Argon was the carrier gas (flow: 60 cm^3/min). Identification was carried out by the comparison of peak retention times in the control mixture and analyzed samples. Quantitative determinations were performed using a Unicam 4880 computer program.

Linear correlations were calculated between the concentration of chlorinated hydrocarbons in blood and eggs yolk and number, mass and hatchability of fertile eggs.

Results and discussion

The content of γ-HCH in blood of turkeys (tab. 1) was low throughout the laying period and reached from 0.0001 ng/g in 19-20 weeks to 0.0003 ng/g in 11-12 weeks. Negligible changes were noted in the concentrations of DDE and DDD. The DDE concentration decreased from 0.0026 ng/g in the 3-4 weeks to 0.0006 ng/g in 19-20 weeks, while that of DDD increased from 0.0001 ng/g in 3-4 weeks up to 0.0007 ng/g in 19-20 week. At the beginning (3-4 week) as well as in the peak of laying period (11-12 week), no concentration of DDT was observed in the blood of turkeys. The content of that compound reach 0.0069 ng/g at the end of the reproductive period of the laying hens. The low content of chlorinated hydrocarbons in the blood of turkey hens was probably caused by their low content in the applied full-ration fodder mixture: γ-HCH – 0.0128, DDE – 0,0177, DDD – 0.0155 and DDT – 0.0001 ng/g. The effect of the concentration of chlorinated hydrocarbons in the fodder mixture on their content in blood was confirmed in the studies of other authors (5, 14).

The content of chlorinated hydrocarbons in the turkey egg yolk lipids (tab. 2) was diversified depending on the laying period. The highest contents of DDD (0.0069 ng/g) and DDT (0.0067 ng/g) were found at 3-4 weeks, while those of DDD (0.0008 ng/g) and γ-HCH (0.0269 ng/g) at 11-12 and 19-20 weeks, respectively. In the previous studies conducted on hen eggs (17) and goose eggs (16), significantly higher concentrations of chlorinated hydrocarbons were observed. Niewiadomska et al. (11) informs about numerous cases of exceeding the pesticides' limits in the eggs of hens kept in by-pen conditions.

In blood samples of turkey hens, linear correlation coefficients were calculated between the content of chlorinated hydrocarbons and: intensity of laying (r = from 0.0483 to 0.2039), number of laid eggs (r = from –0.2773 to –0.0003), weight of eggs (r = from –0.0112 to 0.2012), and hatchability from fertile eggs (r = from 0.0550 to 0.3020), (tab. 3). All correlation coefficients were statistically insignificant. The chlorinated hydrocarbon content was found to have no negative effect on the reproductivity traits of turkey hens.

The linear correlation coefficients between the content of chlorinated hydrocarbons in egg yolk lipids and reproductivity traits of turkey hens have been presen-

ted in tab. 4. A quite surprising statistically significant ($p < 0.05$) correlation was found between the DDE content in egg yolk lipids and hatchability of chickens from fertile eggs reaching r = 0.547. The correlation coefficients calculated between the chlorinated hydrocarbon content and number of laid eggs (r = from –0.235 to 0.134), egg weight (r = 0.222 to 0.314), and hatchability of chickens from fertile eggs (r = 0.102 to 0.321) were statistically insignificant.

In the laying period of 20 weeks, all birds were characterized by good well-being and high reproductivity. Mean number of eggs obtained from one laying hen reached 114, the mean egg weight – 84.6 g, and mean hatchability from fertile eggs – 90.05%.

The presented investigations, as well as those of other authors, Niewiadomska and Żmudzki (10), confirm the opinion of low and devoid of hygienic and toxicological claims concentrations of organochlorine pesticides in raw material of animal origin.

Tab. 3. Linear correlation coefficients between the content of chlorinated hydrocarbons in turkey blood and number of laid eggs, weight of eggs and hatchability from fertile eggs

Specification	γ-HCH	DDE	DDD	DDT	DDE + DDD + DDT
Number of laid eggs	–0.2599	–0.2773	–0.2045	–0.0003	–0.0878
Weight of eggs	0.0128	–0.0112	0.0992	0.2012	0.1754
Hatchability from fertile eggs	0.0550	0.1575	0.1910	0.2924	0.3020

Tab. 4. Linear correlation coefficients between the content of chlorinated hydrocarbons in egg yolk lipids and number of laid eggs, weight of eggs and hatchability from fertile eggs

Specification	γ-HCH	DDE	DDD	DDT	DDE + DDD + DDT
Number of laid eggs	–0.325	0.129	–0.221	0.134	–0.006
Weight of eggs	–0.222	0.168	0.314	0.084	0.227
Hatchability from fertile eggs	0.196	0.547*	0.321	0.102	0.285

Explanation: * – $p < 0.05$

Conclusion

The establishing of the negative influence of chlorinated hydrocarbons on the blood of turkey hens and egg yolk lipids on their reproductivity traits (laying performance, egg weight and hatchability results).

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