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Bacteriological and Parasitological Pollution of the Natural Environment in the Vicinity of a Pig Farm[1]

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Abstract

The objective of this research was to evaluate bacteriological and parasitological pollution levels of soil, groundwater, surface water and river sediment in the vicinity of a pig farm.

The microbiological examinations of soil and water environment within the pig farm area and around it showed considerable pollution with animal droppings and municipal sewage coming from a breeding farm and farm buildings. This was confirmed by the results of examinations based on isolation of bacteria that make intestinal natural microflora: *Escherichia coli, Clostridium perfringens* and enterococcus. In the soil environment there were also determined bacteria *Salmonella sp., Bacillus subtilis, Pseudomonas sp., Proteus sp., Klebsiella sp., Micrococcus sp., Enter obacter aerogenes, Citrobacter sp.y* and *Corynebacterium sp.,* as well as fungi *of Candida* genus. The soil within the farm and around it was infected with eggs and larvae of worms of *Strongylidae* and *Trichostrongylidae* genus, eggs of nematodes of *Trichuris* genus, *Ascaris suum* eggs and oocysts of *Eimeria* genus. Despite a systematic animal disinfestation at the yard for gilts and boars there still occurred great quantities of parasites.

Keywords: pigs farm, bacteriological and parasitological pollution, soil, water, groundwater, sediment.

Introduction

Animal production being a branch of agricultural production does not often agree with the requirements of wildlife protection. Modern agricultural production overburdens the environment with organic substances, mainly droppings, fertilizers and pesticides. Improper storage and management of droppings pollute soil and water with nitrogen and phosphorus compounds. Enormous amounts of harmful gases and dusts reach the atmosphere together with ventilated air. As a consequence, the physical and chemical properties of the natural environment change until they are irreversible. Mass production of solid animal manure, liquid manure and sewage in such a small area may be a serious hazard for biological balance. Due to this, local microbiological and parasitological pollution of soil and plants is likely to happen and will affect animals and humans. The objective of the examinations carried out was to estimate a bacteriological and parasitological pollution level of the natural environment around a pig farm.

Material and Methods

The examinations were made in the direct vicinity of a breeding pig farm in "P" place, with a mean stock of 5200 animals. The animals were kept in the bedding system on a shallow litter removed regularly every day. Animal droppings as manure were gathered near farm livestock buildings and taken to fields.

The farm is located in the southern part of Grzeda Sokolska. The southern part of the farm is a flat depression covered with permanent grasslands, while its north-

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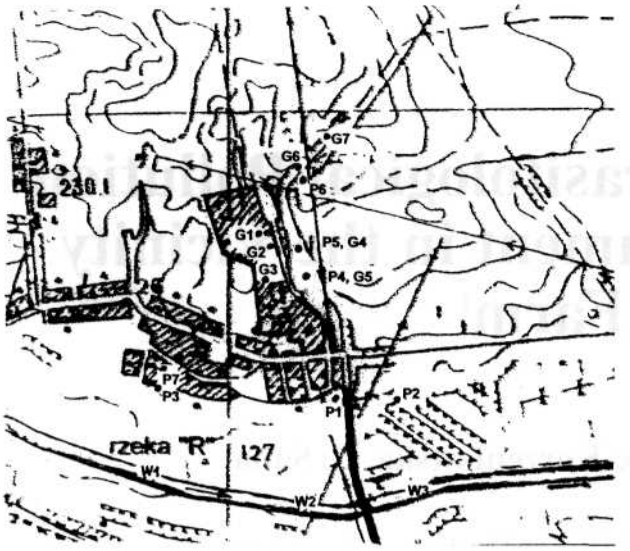

Fig. 1. Places of collected of water and soil samples.

em part - a plain, is slightly rolling and sloping towards the south.

The geological constitution of this region shows the main contribution of loesses and silts reaching down to 15 m depth. The first water-bearing stage is made by marls. The water level appears at the depth of 10-15 m b.s.l.

A small river "R" flows within of 0.5-1 km of the farm border.

The studied material was made by soil, ground and surface water as well as sediment collected from the river (Fig. 1). The sampling took place in an autumn-winter period (from Oct. to March) and spring-summer (from April to Sept.) for two years' time. There were ten series of examinations performed altogether (5 series in the autumn - winter period and 5 the spring -summer period).

The soil samples were gathered from the 7 points at the farm: (Gl) - yard for gilts and piglets; (G2) - yard for boars; (G3) - in the middle of the farm near a communication road; (G4) - at pasture, 100 m of the farm border at the spot of silage juice effluent (G5) - at pasture, at the point of liquid manure effluent from dung-hill; (G6) t pasture, 200 m of farm border; (G7) - at pasture, 400 m of farm border.

Water was sampled at 3 points of the river: (Wl) - at farm border; (W2) - sewage intake at decanter of a closed down treatment plant; (W3) - outside farm border.

Sediment sampling was made at the same points, marked with (01), (O2) and (O3), respectively.

The groundwater samples were collected out of the observational network installed to examine groundwater quality, i.e. 6 piezometers and a dug well. To do that, some geological bore-holes were made down to 5 m depth.

The piezometers were produced from fully inactive material (PEHD), while the filters were additionally protected against silting up by a filter gauze. The piezometers were fitted at six different points at a distance of 100 up to 500 m of farm boundary at a depth of 1.5-4.5 m. A piezometer (PI) was located below a block of flats, (P2) outside the built up-area at the edge of field making a line of morphological water-flow, (P3) located furthest of the farm close to buildings, (P4) at pasture, at the point of liquid manure effluent from dung-hill, (P5) located at the pasture at the spot of silage juice effluent and (P6) at the marginal part of the grassland. The groundwater was also sampled from a dug well at 5.5 m depth (P7) used for over 30 years.

The examinations on soil pollution were carried out considering the microbiological and parasitological indicators.

The soil samples were collected in clean plastic bags with disinfected spatulas from 15-20 cm depth in accordance with "The methodical instructions (microbiological and parasitological) for soil sanitary state assessment." [13].

The water samples for bacteriological examinations were gathered in sterile glass vessels (250. ml each), for physical and chemical examinations to one liter clean bottles previously flushed three times. The water from piezometers was collected by means of an electric pump till a piezometer was emptied completely.

The evaluation of hygienic quality of surface and groundwater was made by bacteriological determinations. Some parasitological examinations of river sediment were executed additionally.

A microbiological analysis of soil, water and sediment samples covered identification of: *Corynebacterium pseudotuberculosis, Erysipelothrix insidiosa, Listeria monocytogenes, Salmonella, Klebsiella sp., Micrococcus sp., Bacillus subtilis, Pseudomonas sp., Proteus sp., Corynebacterium sp., Enterobacter aerogenes., Flavobacterium sp., Citrobacter sp.,* and fungi *Candida sp.* The bacteria were identified by means of the adequate biochemical series API of bioMerieux firm.

The most probable number (MPN) of enterococcus were determined according to the PN 82 C-0461 15.25. Titre of *E.coli* was fixed ace. to the systematic principles (microbiological-parasitological) for soil sanitary state evaluation [13]. To determine likely presence of alimentary tract parasites (nematodes), the soil samples and sediment were examined after Quinn et al. method [6].

Results and Discussion

The microbiological examinations of soil and water environment at a pig farm and around it showed serious pollution with animal droppings and municipal waste coming from a breeding farm and blocks of flats. That was proved by the results of examinations based on isolation of bacteria making natural intestinal flora: *Escherichia coli, Clostridium perfringens* and enterococcus (Table 1 and 2). (The Tables present a range of result obtained in all the series of experiments).

The most polluted with faecal bacteria proved to be the yard for gilts (Gl) and boars (G2). An increased value of intestinal flora was recorded in the middle of the farm (G3) as well as at the pasture at the spot of liquid manure (G5) and silage juice effluent (G4). The highest pollution level was noted in groundwater at the pasture where liquid manure from the farm (P4) was disposed of and *E.coli* titre reached 0.001. These results correlate to those

Table 1. Bacteriological examinations of soil (+ presence recorded).

Determination	G1	G2	G3	G4	G5	G6	G7
Quantitative determination							
1. Titre of *E. coli*	0.01	0.1	0.1	0.01	0.1	0.1	0.01
2. Titre of *Clostridium perfringens*	0.001	0.01	0.0001	–	0.001	0.001	0.01
3. MPN of enterococcus in 100 g	0	0-5	2	1-3	0-4	0-3	0
Qualitative determination							
1. *Corynebacterium pseudotubercutosis*	–	–	–	–	–	–	–
2. *Erysipelothrix insidiosa*	–	–	–	–	–	–	–
3. *Listeria monocytogenes*	–	–	–	–	–	–	–
4. *Salmonella* sp.	+	–	–	–	+	+	–
5. *Klebsiella* sp.	+	–	–	–	–	+	–
6. *Micrococcus* sp.	–	+	–	–	–	–	–
7. *Bacillus subtilis*	+	+	–	+	+	+	+
9. *Pseudomonas* sp.	+	+	–	+	+	–	–
10. *Proteus* sp.	+	+	+	+	+	+	+
11. *Corynebacterium* sp.	–	–	–	–	–	–	+
12. *Enterobacter aerogenes*	–	–	–	+	–	–	–
13. *Flavobacterium* sp.	–	–	–	–	–	–	–
14. *Citrobacter* sp.	–	–	+	–	–	–	–
15. *Candida* sp.	+	+	–	–	+	+	–

Table 2. Bacteriological examinations of groundwater (+ presence recorded).

Determination	P1	P2	P3	P4	P5	P6	P7
Quantitative determination							
1. Titre of *E. coli*	0.001	0.001	0.1	0.001	0.001	0.1	0.01
2. Titre of *Clostridium perfringens*	0.001	0.01	0.0001	0.001	0.001	0.01	0.01
3. MPN of enterococcus in 100 g	0	0-5	2	0-3	0-4	1-3	0
Qualitative determination							
1. *Corynebacterium pseudotubercutosis*	–	–	–	–	–	–	–
2. *Erysipelothrix insidiosa*	–	–	–	–	–	–	–
3. *Listeria monocytogenes*	–	–	–	–	–	–	–
4. *Salmonella* sp.	–	–	–	–	–	–	–
5. *Klebsiella* sp.	–	–	–	–	–	–	–
6. *Micrococcus* sp.	–	+	–	–	–	–	–
7. *Bacillus subtilis*	–	–	–	–	–	–	–
8. *Candida* sp.	–	–	–	–	–	–	–
9. *Pseudomonas* sp.	+	–	–	+	+	–	–
10. *Proteus* sp.	–	–	–	–	–	–	–
11. *Corynebacterium* sp.	–	–	–	–	–	–	–
12. *Enterobacter aerogenes*	–	–	–	–	–	–	–
13. *Flavobacterium* sp.	–	–	–	–	–	–	–
14. *Citrobacter* sp.	–	–	–	–	–	–	–
15. *Candida* sp.	–	–	–	–	–	–	–

Table 3. Bacteriological examination of river water and sediment (+ presence recorded).

Determination	W1	W2	W3	O1	O2	O3
Quantitative determination						
1. Titre of *E. coli*	0.01	0.01	0.01	0.1	1	0.1
2. Titre of *Clostridium perfringens*	–	–	–	0.1	0.1	0.1
3. MPN of enterococcus in 100 g	0-3	1-7	0-10	1	3	0
Qualitative determination						
1. *Corynebacterium pseudotubercutosis*	–	–	–	–	–	–
2. *Erysipelothrix insidiosa*	–	–	–	–	–	–
3. *Listeria monocytogenes*	–	–	–	–	–	–
4. *Salmonella* sp.	–	–	–	–	–	–
5. *Klebsiella* sp.	+	–	–	–	–	–
6. *Micrococcus* sp.	–	+	–	–	–	–
7. *Bacillus subtilis*	–	–	–	–	–	–
9. *Pseudomonas* sp.	–	–	–	–	+	+
10. *Proteus* sp.	–	–	–	–	–	–
11. *Corynebacterium* sp.	–	–	–	–	–	–
12. *Enterobacter aerogenes*	–	–	–	–	–	–
13. *Flavobacterium* sp.	–	–	–	+	–	–
14. *Citrobacter* sp.	–	–	–	–	–	–
15. *Candida* sp.	–	–	–	–	–	–

obtained by Fie et al. [3] who recorded the lowest *E.coli* titre (1 - $3x10^{-4}$), that is the highest pollution with faecal bacteria, in the groundwater close to the manure heap. The present author did not state any pollutant movement beyond the farm, yet his own research confirmed the existence of permanent pressure of the farm on the adjacent area. The presence *of E.coli* and *Clostridium perjringens* was recorded in groundwater as far as 300 m below the farm and blocks of flats (PI).

There is a possibility of the microorganism displacement even 2 m deep inside a soil profile. Many works [1, 7, 11, 14] prove that use of droppings for manuring, especially onto permeable land, may bring about the infection of shallow water-bearing layers and in turn, some sources of water. The geological constitution of the area, slightly permeable loess layer of the topsoil together with a morphological depression, caused the impurities surface runoff to the river. The runoff from the bacteriologicaly infected area brought a serious share of the pollutants directly to water-courses and surface waters. The fact that faecal impurities reached the river is indicative of an increase of enterococcus content down the river course, below the area of farm influence and sewage release from farm workers blocks of flats (W3) (Table 3).

The inland water's quality (purity grade) has been often decreased due to bacteriological pollution. *E.coli* titre of river water at the experimental period was 0.01 that classified the water to Illrd purity grade. On the basis of the examinations a serious effect of a farm on the sanitary state of soil and river water purity was stated. They also demonstrate that evaluating a breeding farm sanitary state as well as investigation on pression on the environment of places like these, need the monitoring of all the likely ways of pollutants penetration.

Soil infection with non-disinfected animal manure causes risks of introduction of other bacteria originating in the intestine i.e. pathogens or conditional pathogens [2, 5, 8, 15].

Particularly dangerous proved to be bacteria of *Salmonella* genus. The soil bacteriological examinations revealed that the environment was contaminated with these rods (Gl, G5, G6). Although *Salmonella* presence confirmed in the soils examined was occasional, still even their small count should be alarming because they can easily spread under favourable conditions and make a serious source of environmental pollution.

Infections and poisonings incited by *Salmonella* rods are wide spread and affect both, man and animals (all species of farm animals or free-living). In the works by Slawon et al. [10] and Saba et al. [9] the attention is drawn to these bacteria presence in fur bearing animal farms. The authors state that the environment has been in danger of being polluted with *Salmonella* rods coming from breeding farms. A great concentration of animals at confined space is quite conducive for pathogenic factor transfer among animals, therefore in breeding farms an epizootic outbreak is observed more often.

The soil microbiological examinations also showed its pollution with other bacteria. The following bacteria: *Bacillus subtilis, Pseudomonas sp., Proteus sp.,* were

Table 4. Parasitological examinations of soil and sediment.

	Developmental form/species	Soil							Sediment		
		G1	G2	G3	G4	G5	G6	G7	O1	O2	O3
1.	Eggs of *Rhabditis* spp.	4	12	0	0	0	2	0	0	0	0
2.	Oocysts of *Eimeria* spp.	0	0-2	0	0-6	0	3	6	0	0	0
3.	Eggs of *Trichuris* spp.	1	8	2	0-15	0-22	0	0	0	0	0
4.	Eggs of *Ascaris suum*	0-2	10	1-6	1-5	0-4	0-6	0-2	0	0	0
5.	Eggs of *Toxascaris leonina*	0	0	1	0	0	0	0	0	0	0
6.	Eggs of *Strongylidae* or *Trichostrongylidae*	0	0	2-5	4-7	1	3	0	0	0	0
7.	Eggs of *Strongylidae* or *Trichostrongylidae* with larvae	40	0-5	0-11	0	0-2	0	0-1	0	0	0
8.	Saprobiontic nematodes or their larvae	1-35	hun-dreds	32	6	4-5	4-28	2	0	2	0
9.	Eggs of acarids (*Arachnoideae*)	5	0	0	0	0	0	0	0	6	0

recorded in nearly all the places inspected, where as *Klebsiella sp., Micrococcus sp.* rather rarely (Gl, G2, G6). At the farm and its close vicinity there were also noted, in single samples, *Enterobacter aerogenes, Citrobacter* and *Candida* genus fungi too (Gl, G2, G5, G6). As far as 400 m of the farm border *Cotynebacterium sp.* presence was confirmed. However, as Krogulska [4] holds, the microorganisms appear naturally in the environment and are not man's pathogens; still, they can concur to the occurrence of disease symptoms under some conditions and be a cause of various kinds of infections. It is of prime concern to the people with an attenuated immunity mechanism, those treated with immunosuppressants, suffering from AIDS, elderly and infants [4].

Thus, a fact of the microorganism presence in the examined river waters, farm groundwater and its surroundings seems to be alarming. The examinations have not verified the presence of pathogens and conditional pathogens such as *Corynebacterium pseudotuberculosis, Erysipelothrix insidiosa, Listeria monocytogenes.* That is why it can be stated that there was no direct threat to human or animal life owing to the germs mentioned above.

Breeding farms can also make a potential source of parasitological pollution of soil and water. The most often occurring parasites were found to be protozoa of *Eimeria* genus. Oocysts of coccidia resistant to the external environment are able to survive in a free, invasive state for a couple of months. The examinations showed oocyst of *Eimeria* genus to appear at the yard for animals (G2) and 100 m (G4), 200 m (G6) and 400 m (G7) of farm border (Table 4).

Strauch [12] found that apart from *Eimeria* oocysts, the common presence of gastrointestinal parasites eggs, *Ascaris suum* in particular, was recorded in pig excrement. The present examinations demonstrated the eggs' presence in the soil sampled in all the places evaluated.

A considerable spread within the farm and its proximity also refered to the eggs of *Strongylidae* and *Trichostrongylidae* genus worms. It was characteristic that the greatest quantity of eggs and larval forms of parasites was noted in the middle of the farm and a place of liquid manure effluent (G5).

Alike, yet in a lot greater amount there appeared nematodes eggs of *Trichuris* genus (whipworms). It proves a substantial frequency of whipworms but not considerable spreading.

There was no record of presence of developmental forms of invasive parasites in the sediment of river "R" flowing near the farm. Only saprobiontic nematodes eggs and larvae as well as *Arachnoideae* eggs were observed there. The searching for some developmental forms of parasites in surface water flowing round the farm is fairly difficult technically so the examinations for their presence were made in the sediment. However, lack of confirmation in regard to their presence cannot be considered as an explicit proof of absence of pollution with these parasites. What should be taken into account is a high rate of water flow and washing any pollutant out of the sediment.

Admitting a vital role of soil in the epidemiology of some parasitic diseases there were worked out the helminthologic indices for soil sanitary state evaluation. According to the criteria established by the Ministry of Health and Social Welfare in Poland, 1986 a sanitary state of soil containing more than 2 eggs in 1 kg of alimentary tract parasites should be considered improper. The Institute for Rural Medicine allows maximum parasite limit from 0 up to only 10 units in 1 kg of pure soil [13]. On the basis of the above mentioned criteria it may be stated that a sanitary state of soil examined was poor and a pig farm made a source of invasive hazard with various parasitic forms. The soil parasitological examinations revealed that 1 kg of the soil contained from 1 to 43 eggs and larvae of alimentary tract parasites.

Pathogens or conditional pathogens, fungi, parasitic developmental forms enter the soil and water mainly with animal droppings and waste. Thus, it is a high priority to

comply with the rules of hygienic use of organic fertilization of cultivated fields and pastures as well as control of sewage disposal of farm buildings. That is of prime concern to large animal farms with a great number of animals.

Conclusions

1. The microbiological examinations of soil and water environment showed the occurrence of bacteria making the natural intestinal microflora: *Escherichia coli*, *Clostridium perjringens* and enterococcus that confirms the environmental pollution with animal droppings.

2. In the soil environment was also recorded presence of bacteria *Salmonella sp., Bacillus subtilis, Pseudomonas sp., Proteus sp., Klebsiella sp., Micrococcus sp., Enterobacter aerogenes, Citrobacter sp., and Corynebacterium sp.,* as well as fungi *of Candida* genus.

3. The soil within the farm and around it was infected with eggs and larvae of worms of *Strongylidae* and *Trichostrongylidae* genus, eggs of nematodes of *Trichuris* genus, *Ascaris suum* eggs and oocysts of *Eimeria* genus. A great quantity of parasites occuring in the yard for gilts and boars made a serious hazard.

References

1. BOMBIK T., SABA L.: Wplyw glebokosci studni przydomowych na stan zanieczyszczen chemicznych i bakteriologicznych wody. Materialy IX Kongresu Olsztyn **1992.**
2. CZERMOMYSY-FUROWICZ D, FUROWICZ A. J.: Bakterie patogenne w glebie - zagrozenia epizootiologiczne i epidemiologiczne. Przeglad hodowlany **3,** 26, **1996.**
3. FIC M., SLOMCZYNSKI T, SABA L.: Mikrobiologiczne zanieczyszczenie wod gruntowych w zlewniach sandru kurpiowskiego. II Forum Inzynierii Ekologicznej Nalijczow, 369-377, **1998.**
4. KROGULSKA B.: Zanieczyszczenie mikrobiologiczne, wskazniki sanitarne i metody kontroli jakosci wody do picia i na potrzeby gospodarcze. Przemysl Spozywczy, **6,** 17,**1996.**
5. MARKERT T.: Moglichkeiten zur chemischen Desinfection von Salmonnellen in Scheinneflussigmist und die Auswirkungen der anchliessenden Ausbringung auf Griinland. Univ. Giessen, 1990.
6. OUIMI R, SMITH H.V., BRUCE R.G., GIRDWOOD R.A.: Studies on the incidence4 of Toxocara and Toxascaris sp. ova in the Environment. I.A. Comparison of Floation Procedures for Recivesing Toxocara sp. ova from soil. J. Hyg. Camb. **84,** 83, **1980.**
7. PALUSZAK Z.: Ekologiczne aspekty stosowania gnojowicy w oparciu o zachowanie sil bakterii fekalnych w glebie. Materialy na Sympozjum; Problemy higieny w ekologizacji rolnictwa. 185-191, Warszawa **1997.**
8. PLYM FORSHELL L., EKESBO I.: Survival of Salmonellas in Composted and not composted solid Animal Manures. J. Vet. Med. B **40,** 654, **1993.**
9. SABA L, SLA WON J., POLONIS A, BIS-WENCEL H.: Zanieczyszczenie gleby i powietrza przez fermy miesozernych zwierzat futerkowych. Annales UMCS vol. XI, 31, sectio EE, 215-222, **1993.**
10. SLA WON **J.,** SABA L., BIS-WENCEL H., WENCEL C: Paleczki salmonelli w srodowisku ferm miesozernych zwierzat futerkowych. Medycyna Wet. . **11,** 545, **1994.**
11. STRAUCH D, BALLARINI G.: Hygienic Aspects of the production and Agricultural use of animal wastes. **J.** Vet. Med. B, **41,** 173, **1994.**
12. STRAUCH D.: Przezywalnosc drobnoustrojow chorobotworczych i pasozytow w wydalinach, nawozie i szlamie sciekowym. Cz. II. Medycyna Wet. **3,** 117, **1993.**
13. STROCZYNSKA-SIKORSKA M, KLAPEC T, CHOLEWA A.: Wytyczne metodyczne (mikrobiologiczno-parazytologiczne) do oceny sanitarnej gleby. Instytut Medycyny Wsi. Lublin **1995.**
14. STRZALKOWSKI L., KOPCZEWSKI A.: Przezywalnosc w ziemi i w wodzie paleczek z rodzaju Salmonella izolowanych od lisow. Medycyna Wet. **47,** 397, **1991.**
15. VALLET A., MARKY J.: Survival of Salmonellae in cattle slurry and his chemical desinfections. 9^{lh} Int. Cong. Anim. Hyg. Helsinki II, 738-741, **1997.**