LIQUID MANURE FROM PIG BREEDING FACILITIES AS A POTENTIAL WATER CONTAMINANT

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Introduction

Intensive pig breeding used for the last fifty years has resulted in several-fold increase in the productivity of this livestock production system. However, modern technology achievements in pig breeding take their toll in the form of both immediate and general environmental hazards. The potential adverse environmental effects, mostly due to liquid waste abundance, generally manifest on water flows and drinking water resources.

Based on these considerations, samples of water used for drinking and watering taken from a spring, artesian wells and sweep wells in the Sava River basin in west Slavonia, Croatia, were analyzed. A swine farm with about 25,000 fattening pigs *per* year has been operating in the area for some thirty years. The liquid manure produced on the farm is being processed and discharged through the lagoon system onto 800 ha of arable land as replenishment for crops, mostly cereals.

The aim of the study was determine the quality of water in the area with respect to the animal waste from the swine farm and surrounding fields.

Material and methods

Water samples were collected in west Slavonia, Croatia, from a spring at 5 km north-east from the pig farm, three sweep wells at 2 km north-west and west from the pig farm, and two artesian wells in the farm yard. The depth of artesian wells is 60 m and 70 m, and of sweep wells 6-8 m.

The concentrations of ammonia (NH_4^+), nitrate (NO_3^-) and nitrite (NO_2^-) were determined by standard spectrophotometric methods of absorbance measurement at 425 nm, 220 nm and 520 nm, respectively. Residues of the s-triazine herbicide atrazine were determined by the enzyme-linked immunosorbent assay (ELISA). Water sampling was performed in autumn, winter, spring and summer 2002/2003.

West Slavonia is an agrarian region of Croatia with a strong tradition of pig breeding. A swine farm with about 25,000 fattening pigs *per* year has been operating in the area for some thirty years now.

Results

The ammonia and nitrite concentrations were higher in the spring and sweep well water than in the artesian well water. In the spring water sample, the concentration of ammonia was higher in autumn and that of nitrite in summer, whereas the sweep well water sample contained highest ammonia concentration in summer (Table 1).

In spring water, the concentration of nitrate was highest in autumn. Other water samples showed rather uniform concentrations of nitrate and atrazine residues across the seasons of the year (Table 2).

Discussion

Studies of drinking water quality generally use a dual approach. One approach is focused on the protection of human health, whereas the other investigates the effect of potential contaminants on the food chain and on the environment in general. Studies of the quality of water used in food animal watering should be incorporated in-between, as inappropriate watering of food animals implies a health risk for both animals and humans.

The monitoring of animal health and productivity in intensive pig breeding in west Slavonia offered an opportunity to analyze the quality of watering. For this purpose, water samples were collected in 2002/2003 at three-month intervals from the farm well, a spring, and a number of wells in the village. The aim of the analysis was to identify the potential relationship between the agricultural and livestock activities and water quality, considering that the latter is associated with production of adverse substances that pose a health risk upon reaching waters.

In the present study, the concentrations of nitrogen and atrazine (a herbicide) as potential drinking water and watering contaminants were analyzed. Nitrogen as an essential element is being constantly recycled *via* plants and animals. The cycle includes animal feces, wherefrom the ammonia, nitrate and nitrite are converted by soil bacteria into ammonia cation (NH_4^+) or nitrate anion (NO_3^-), the nitrogen forms acceptable to plants. Animal waste discharged to arable land at appropriate agrotechnical timing and in appropriate amount is utilized by the crops during the period of vegetation. In case of inappropriate procedure, nitrogen will reach waters through simple washing out. Thus, for example, the multiple-fold ammonia (NH_4^+) and nitrite (NO_2^-) concentrations in creek water returned to the prefertilization level in 60 days of

spreading pig manure over the surrounding fields (Hadžiosmanovic et al., 1994). Vucemilo et al. (1997) report on a similar pattern of ammonia and nitrite in a natural water flow following the inflow of swine farm waste water and arable land draining waters, suggesting the observed water flow to be classified as water category II-III.

The increased concentration of ammonia in spring water in autumn and well water in summer, and of nitrite in summer and of nitrate in autumn in spring water (Tables 1 and 2) reflect the precipitation pattern in the area. The uniform levels of the observed parameters in artesian well water indicate the microbiological and biochemical activity of the soil to be still capable of degradation of the potential underground water contaminants.

In spite of the concentrations recorded, the parameters analyzed in the water types (Tables 1 and 2) meet the Croatian legal provisions on their maximal allowed concentrations (Official Gazette 182/04, adjusted to EC 98/83).

The concentrations of ammonia (NH_4^+), nitrite (NO_2^-) and nitrate (NO_3^-) were consistent with the previously reported findings in village well waters from a comparable agrarian area (Hadžiosmanovic et al., 1997).

The concentration of atrazine (Table 2) also corresponded to the reference value, specifically pointing to an appropriate use of the herbicide.

Conclusion

Results of the analysis of water sampled from three different water sources pointed to a conclusion that the animal waste utilized on arable land did not cause water contamination with nitrogen and nitrogen compounds. The same held true for the herbicide atrazine because the measured concentrations met the respective legal provisions. The results were found to be consistent with appropriate utilization of liquid manure for soil fertilization as well as with agrotechnical terms for crop treatment and protection.

In a word, good agricultural practice is not a demagogy but a technology proving the possibility of pig breeding and land cultivation coexistence without any major immediate or general environmental hazards. Regular monitoring and proper information on environmental events in general will reduce the potential risk and understandable fears.

References

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Table 1. Ammonia and nitrite concentrations in samples of water for drinking and watering according to well type and season 2002/2003

Sampling time	Ammonia (mg N/L)			Nitrite (mg N/L)		
	Spring (n=8)	Artesian well (n=16)	Sweep well (n=24)	Spring (n=8)	Artesian well (n=16)	Sweep well (n=24)
Autumn	0.38	0.07	0.20	0.019	0.007	0.027
Winter	0.21	0.11	0.19	0.007	0.008	0.013
Spring	0.13	0.11	0.16	0.130	0.010	0.028
Summer	0.14	0.13	0.49	0.140	0.008	0.090

Table 2. Nitrate and atrazine concentrations in samples of water for drinking and watering according to well type and season 2002/2003

Sampling time	Nitrate (mg N/L)			Atrazine (mg N/L)		
	Spring (n=8)	Artesian well (n=16)	Sweep well (n=24)	Spring (n=8)	Artesian well (n=16)	Sweep well (n=24)
Autumn	6.2	1.9	4.4	0.0	0.02	0.06
Winter	5.6	1.6	4.7	0.0	0.02	0.02
Spring	3.5	1.7	3.4	0.0	0.0	0.02
Summer	3.1	1.6	4.2	0.0	0.0	0.07