Association between over-chlorinated drinking water and suckling, nursery and fattening pig death losses

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ABSTRACT: Following our report on reproductive failure in gilts and sows caused by drinking over-chlorinated water at a pig-breeding farm, the present study investigated the impact of water over-chlorination on the different pig production categories on the farm. Pigs were given over-chlorinated water with a free chlorine residual concentration of 2.11 mg/l for seven days, from the onset of mechanical failure of the chlorinator dispenser connected to the water supplying system until its detection. Data analysis revealed that the adverse effect of over-chlorinated drinking water manifested as an increase in the percentage of death losses in suckling, nursery and fattening pigs (all $P < 0.01$).

Keywords: death loss; pig; watering; free chlorine residual

Water has a fundamental role in a number of physiological processes and is the most critical nutrient for animals and humans. According to the Council Directive 2008/120/EC and regulations in force in Croatia (Anonymous, 2010), all pigs over two weeks of age must have permanent access to fresh water, the quantity of which depends on the different physiological, nutritional and environmental charactersitics of pigs (Olkowski, 2009). However, along with water quantity, its quality is also of paramount importance (Tofant et al., 2008). Poor water quality can impair health, reduce productivity and cause death in severe cases (Patience, 1989), leading to poor pig welfare and economic losses for the producer.

The results of our previous study indicated that over-chlorinated drinking water on a pig-breeding farm was the cause of reproductive failure, and increased the number of spontaneous abortions, the number of pigs returning to oestrus and percentage of stillbirths, while reducing farrowing and the total number of piglets in gilts and sows (Tofant et al., 2010). These findings prompted us to investigate the possible effects of over-chlorinated water upon particular pig production categories at the farm.

In this study, the possible association between death losses in suckling, nursery and fattening pigs and over-chlorinated drinking water was investigated.

MATERIAL AND METHODS

Animals. The study was carried out at an intensive pig breeding farm and included data on 12 215 pig death losses in suckling, nursery and fattening pigs of Swedish Landrace, Large White, Pietrain breeds and their crossbreeds. The pigs were accommodated in appropriate housing and microclimate conditions in all production facilities, farrowing, nursery and fattening units, and were fed safe feed. The suckling period lasted for one month, nursery two months and fattening four months, on average.

Watering system and disinfectant. See the study of Tofant et al. (2010).

Case description

On October 2, 2005, the same symptoms as those observed in gilts and sows (Tofant et al., 2010), were also recorded in suckling, nursery and fattening pigs. The animals were listless, had poor appetite and dyspnea, sneezed and coughed, but were afebrile. Their blood samples were also referred for laboratory analysis on October 4, 2005. The usual causes of infectious diseases were ruled out by diagnostic work-up. On October 4, a water sample was referred for safety analysis. The results with regard to organoleptic, physicochemical and bacteriological parameters, received on October 7, met the Croatian standards for drinking water (Anonymous, 2008), i.e., they were acceptable in terms of safety, with the exception of the free chlorine residual level, which was 2.11 mg/l, exceeding manifold the maximum allowable concentration of 0.5 mg/l. This was connected with the failure of a chlorine dispenser that had been put in operation on October 1 because of a deterioration in bacteriological water quality due to the rainy season. Large-scale death losses in farm pigs occurred over about two weeks after the failure of the chlorine dispenser was detected on October 7. Postmortem analysis of pig carcasses in this period and later generally revealed fibrinous and fibrinous-suppurative pneumonia, and in some animals signs of colisepticaemia.

Statistical analysis

Statistical analysis was performed using the Statistica 8.0 (Statsoft Inc., 2008) software. Basic data processing was done using descriptive statistics methods. The Mann-Whitney *U*-test was used to compare normal standard values (NSV) and chlorine-affected values (ClV) of the pig death losses observed.

RESULTS AND DISCUSSION

In this study, which follows on from the case report of Tofant et al. (2010), the effects of over-chlorinated water on pig production categories were investigated. Data referring to death losses of suckling, nursery and fattening pigs were analyzed for the same period as the above study, from January 2005 until April 2006. As the toxic effects of over-chlorinated water on a particular pig category manifested for a variable period of time, the number of months (*n*) taken to calculate mean NSV and ClV of death losses varied according to pig category (Table 1).

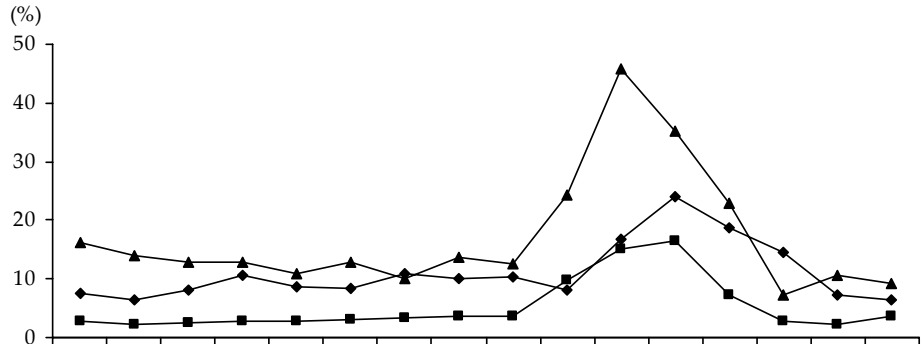
The etiology of death losses in intensive pig production varies according to the stage of production. The most common causes of death reported in suckling pigs are crushing by the sow, starvation and diarrhoea (Lay et al., 2002; Shankar et al., 2009). In nursery pigs, death losses are mostly caused by weaning associated stress and consequent susceptibility to infections, in particular *Escherichia coli* (Straw et al., 2006). In fattening pigs, gastrointestinal, respiratory and locomotor system diseases are the most common causes of death losses (Schoder et al., 1993; Baumann and Bilkei, 2002).

In this case, pig losses were related to water over-chlorination with a free residual chlorine concentration which massively exceeded the maximal allowable concentration. The animals were subjected to this subacute exposure to over-chlorinated water for seven days, i.e., October 1–7, 2005.

Table 1. Pig death losses during the study period

Parameter (%)	NSV		ClV		*P*-value
	n	mean ± SD	*n*	mean ± SD	
Suckling death loss	12	11.90 ± 2.43	4 (October-January)	31.99 ± 10.63	< 0.01
Nursery death loss	12	8.55 ± 1.59	4 (November-February)	18.57 ± 4.12	< 0.01
Fattening death loss	12	2.97 ± 0.54	4 (October-January)	12.09 ± 4.42	< 0.01

n = number of months taken into consideration for calculating mean NSV and ClV
NSV = mean standard values of pig death losses in months free from the toxic effect of water over-chlorination
ClV = mean values of pig death losses in months when the toxic effect of water over-chlorination manifested



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
	2005												2006			
Suckling death loss	16.3	13.9	12.9	12.8	11	12.8	9.95	13.7	12.5	24.3	45.7	35.1	22.9	7.24	10.5	9.25
Nursery death loss	7.42	6.38	8.08	10.7	8.6	8.48	10.8	10	10.3	8.21	16.9	24.1	18.8	14.4	7.19	6.38
Fattening death loss	2.66	2.34	2.38	2.9	2.86	3.12	3.38	3.56	3.75	9.64	15.2	16.4	7.14	2.88	2.13	3.64

Figure 1. Suckling, nursery and fattening pig death losses during the study period

The toxic effect of over-chlorinated drinking water resulted in a significantly higher percentage of death losses in suckling pigs ($P < 0.01$) over four months, from October 2005 to January 2006 (Table 1, Figure 1). The losses included suckling pigs using over-chlorinated water at the beginning of October, piglets drawing milk from the dams which had consumed over-chlorinated water, and piglets whose dams had used over-chlorinated water and gave birth to the litter after this period (Tofant et al., 2010).

The adverse effect of over-chlorinated drinking water also had a significant impact on the percentage of death losses in nursery pigs ($P < 0.01$) over four months, from November 2005 to February 2006 (Table 1, Figure 1). The losses affected nursery pigs using over-chlorinated water at the beginning of October in the nursery stage and suckling pigs transferred to the nursery unit during or after the toxic period. The first losses in nursery pigs associated with over-chlorinated drinking water had probably occurred as early as October, but a higher rate of losses was only recorded in November (Table 1, Figure 1).

In fattening pigs, adverse sequences of water over-chlorination manifested as a significantly increased percentage of death losses ($P < 0.01$) over four months, from October 2005 to January 2006 (Table 1, Figure 1). This percentage included fattening pigs using over-chlorinated water at the beginning of October, in the fattening stage, nursery pigs transferred to the fattening unit during or after the toxic period, and possibly also suckling pigs transferred to the nursery unit.

Water over-chlorination at the beginning of October led to death losses in the majority of pig categories as early as that month, while its adverse effects were also observed in the following months. However, it remained unclear whether pig death losses should have been ascribed to the direct effect of free residual chlorine or to water chlorination by-products (Zoeteman et al., 1982; Klotz and Pyrch, 1999; Dodds and King, 2001; Cedergren et al., 2002), and whether over-chlorinated drinking water served as a trigger for the onset of disease in some pigs.

CONCLUSIONS

In conclusion, over-chlorinated drinking water exerted adverse effects on different pig production categories. These adverse effects manifested as an increased percentage of death losses in all production categories, i.e., suckling, nursery and fattening pigs, confirming the importance of monitoring animal drinking water quality.

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