Sewerage overflows put production and fertility of dairy cows at risk

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Abstract

More than 50 % of the dairy farmers in the Netherlands use surface water as the main source of drinking water for their cows during the grazing season. The quality of this water may be affected by discharges from sewerage overflows, but possible effects on health of dairy cows have not been quantified. Our objective, therefore, was to assess the risk of impaired production and fertility in dairy cows that drink surface water in direct contact with a sewerage overflow. Standardized milk production of cows from 60 farms using surface water in direct contact with a sewerage overflow was 0.9 L/d less (P = 0.09) than that of cows from 397 farms using surface water not in contact with an overflow. Also, age at first calving was 20 days higher (P < 0.01) in heifers exposed to drinking water in contact with sewerage overflows. These results strengthen earlier suggestions that sewerage overflows may reduce production and fertility of dairy cows.

Introduction

Approximately 50% of the dairy farmers in the Netherlands use surface water as the main source of drinking water for their cows, especially during the grazing season. With increasing population density, the quality of surface water may be affected by sewage effluents, particularly from sewerage overflows that discharge untreated sewage into surface water. These overflows are designed to discharge approximately 7 times per year (Wiggers, 1993) when supply of sewage is larger than the storage and transport capacity of the sewerage. Overflows occur mainly during heavy rainfalls in the grazing season, and may have a dramatic effect on the quality of the surface water, especially when these are small ditches with a low water flow (de Zwart & Luttik, 1989). After discharge of a sewerage overflow, surface water may have increased concentrations of nutrients, heavy metals (de Zwart & Luttik, 1989), chemical compounds like PAC's, organochloric compounds, detergents and mineral oil (van Campen et al., 1989) and micro-organisms including pathogens like Cryptosporidium and Giardia (Medema & Ketelaars, 1995). These higher concentrations may affect health and fertility of animals drinking this water (WHO, 1989; White et al., 1994; Esteban and Anderson, 1995; Sumpter, 1995; Olson et al. 1996). Approximately 12,000 sewerage overflows exist in the Netherlands and the cows of approximately 1 of every 20 dairy farmers may be at risk (Kuipers, 1996). However, it is not known to what extent the health of cows drinking surface water in direct contact with sewerage overflows is affected. The objective of this study was to assess the risk of impairment of production and fertility of heifers and dairy cows due to their drinking surface water in direct contact with a sewerage overflow.

Material and methods

Data for the comparison were obtained from two different sources. Data about the type of water used as drinking water for the cows and whether this water was in direct contact with a sewerage overflow or not were taken from the 1995 annual inquiry on grassland utilization (Kuipers, 1996). This inquiry is part of the more comprehensive annual agricultural account "Landbouwtelling" (Boers et al., 1995). In addition to the standard survey, the 1995 inquiry on grassland utilization asked 3000 farmers with sheep or cattle about the type of drinking water they used for their animals during the grazing season. Possible answers were surface water, groundwater, tap water, or any combination of these. When surface water was the main source, farmers were asked whether this water was in direct contact with a sewerage overflow (yes, no, not known). From the data of 1783 respondents, we first selected farms with lactating dairy cows (n = 1274). Further, we selected farms where surface water (n = 294), or a combination of surface water and ground- or tap water (n = 344) was used. From this group (n = 638), we selected the farms of farmers who knew whether the surface water was, or was not, in direct contact with a sewerage overflow (n = 508). The postal codes of these farms were then used to select production and fertility data of the cows on these farms from the Royal Dutch Cattle Syndicate (NRS).

The NRS compiles production and fertility data of approximately 90% of the dairy farmers (Wismans, 1992). Individual milk production of dairy cows is surveyed every 3 or 6 weeks (Wilmink, 1987). Data are sent to the farmer as well as to the NRS. Also, the NRS collects all data concerning dates of birth, inseminations, calving and death of individual cows.

The information about the type of drinking water applied to the grazing season of 1995 (approximately May-October). All production and fertility data were selected and averaged for the appropriate periods as follows.

Milk production

Average milk production on the day of the 3 or 6 week milk survey was calculated for each farm. Values were standardized for age of the cow, month of calving and stage of lactation according to NRS procedures (Wilmink, 1987). This standardized milk production is sensitive to changes in management and may also be used to compare differences among farms. The average standardized milk production during the period of 1 May to 1 September of 1995 was calculated for each farm.

Mammary gland health

The number of cells in milk is an indicator of the health of the mammary gland. During mastitis the number of cells in milk increases. For each cow the number of cells in milk was standardized for age at calving and amount of milk produced and expressed as a relative to the normal value (taken as 1). Values were averaged over cows and over the period of 1 May to 1 September 1995.

Fertility of heifers

Age at first insemination, age at first successful insemination and number of inseminations required for pregnancy were calculated for all heifers that were first inseminated during the period of 1 May 1995 to 1 June of 1996. Age at first calving was calculated for all heifers that calved during the period of 1 January to 1 June 1996. Values were averaged for each farm.

Fertility of dairy cows

The interval between calving and first insemination and between calving and successful insemination as well as the number of inseminations required for pregnancy was calculated for each cow that calved during the grazing season (15 April to 1 October) of 1995. Values were averaged for each farm. Cases in which subsequent inseminations were separated by more than 56 days (two cycles) were interpreted as abortions. The number of cows that calved during the grazing season and showed abortions after subsequent insemination was expressed as a percentage of all cows that calved during the grazing season and were subsequently inseminated.

Statistical analysis

The hypothesis that the use of water that has direct contact with a sewerage overflow impairs production and fertility of dairy cows was tested by means of a one-sided two-sample t-test. P-values < 0.10 were considered statistically significant.

Results and Discussion

Standardized milk production was 0.9 L/d lower on farms that used surface water in direct contact with a sewerage overflow (Table 1). There were no differences in the number of cells in milk, indicating that health of the mammary gland was not influenced. Age at first and at succesful insemination was on average 11 days greater for heifers drinking surface water in contact with a sewerage overflow than in other heifers, though this difference was not significant (Table 1). The number of inseminations required for pregnancy was equal in both groups. Heifers in the exposed group that calved in the first half year after the grazing period were significantly older at first calving ($P < 0.01$; Table 1). The difference was almost three weeks. The age at first insemination and number of inseminations were the same in both groups, suggesting that exposure to surface water in direct contact with a sewerage overflow lengthened the pregnancy period of heifers, possibly by slowing growth of the fetus.

There was no difference between exposed and control cows in the interval of calving to first insemination, the interval of calving to successful insemination, number of inseminations required for pregnancy and percentage of abortions (Table 1).

Our study is, to our knowledge, the first attempt to assess the effect of sewerage overflows on a dairy production system with outdoor grazing cattle. Our analysis shows impaired milk production and fertility of cows on farms where surface water in direct contact with a sewerage overflow is used as the main source of drinking water for the cows. We included farmers using a combination of surface water and tap or ground water in the group at risk. This was based on the assumption that surface water was still the main source as it was drunk during the larger (grazing) part of the day, whilst the tap or ground water was supplied in the milking parlor or barn. This is a common practice in the Netherlands. Restricting the group at risk to the farmers that used surface water only did not change essentially any of the effects described herein. However, because of the reduction of the sample size, the P-values increased slightly.

Information about the presence of a sewerage overflow was obtained from the farmers themselves, so this factor may be confounded with other management factors. Unfortunately, it was not possible to identify farmers who unknowingly used surface water that was in direct contact with a sewerage overflow. We think the current analysis is valid because the possible risks of sewerage overflows were not as clear to farmers in 1995, when the data were obtained, as they are now after the public attention drawn to this problem since then. Another argument for the validity of our conclusions is that management factors aimed at increasing milk production in individual cows usually impair fertility (Olds et al., 1979; Rougoor et al. 1996). In our study, both production and fertility were negatively affected.

We eliminated possible effects of factors such as geographical location of farms and farm size, using information from the comprehensive annual survey on agriculture. This was done by means of multiple regression models. There was no indication that the differences in production and fertility between the control and case group as described herein could be attributed to factors other than the overflow connection.

For farmers a loss of 0.9 L/d of standardized milk production equals approximately 0.6 L/d per cow producing 7500 L in 300 days. With an average of 40 cows per farm this adds up to the loss of 7200 L/yr., or the total production of one cow. This loss represents approximately 10% of an average farmer’s income. The financial loss due to impaired fertility of heifers and cows as found in this study further increases the loss of income by approximately 5 % (Dijkhuizen et al. 1985).

We conclude that sewerage overflows affect production and fertility of dairy cows. To solve this problem cows should be prevented from drinking surface water in contact with a sewerage overflow or overflows should be removed from sites where grazing cows drink surface water. Research aimed at the identification and quantification of the hazardous agents involved is needed to distinguish the priority and effectiveness of these costly measures.

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Table 1. Farm averages of production and fertility parameters of heifers and dairy cows as affected by exposure to surface water in direct contact with a sewerage overflow.

Parameter	Water in contact with Sewerage Overflow yes	no	Difference	*P*	95% confidence limit
Number of farms†	50-60	287-397			
Heifers:					
Age at first insemination (d)	523	512	11	0.12	> -5
Age at successful insemination (d)	543	532	11	0.13	> -5
Number of inseminations	1.61	1.65	0.04	0.62	> -0.23
Age at first calving (d)	804	784	20	< 0.01	> 6
Cows:					
Standardized milk production (L/d)	35.9	36.8	-0.9	0.09	< 0.2
Standardized cell numbers in milk	1.18	1.15	0.03	0.37	> -0.14
Calving to first insemination (d)	89	93	-4	0.79	> -11
Calving to successful insemination (d)	128	124	4	0.14	> -2
Number of inseminations	1.80	1.79	0.01	0.41	> -0.09
Abortions (%)	8.3	7.1	1.2	0.12	> -0.47

† Exact number depends on the parameter analyzed.