Characterization of meat plant washwater

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Abstract

Characteristics of meat plant washwater and its suitability to be land-applied for agricultural use were investigated. A survey was sent to meat plants located in Ontario, Canada, and their methods of disposal were determined. Washwater samples were taken from randomly selected meat plants and were analyzed for their chemical constituents. The results obtained from this study fall within the range of the results obtained from other studies. The meat type, presence of blood and the commodity type had a highly significant impact on the biological oxygen demand (BOD), total Kjeldahl nitrogen (TKN) and total solids (TS). The concentration of metals present is very low and if the washwater is land applied properly, the risk to the environment is minimal.

Introduction

Washwater is generated throughout various parts of the slaughtering and processing operations. Washwater is generally collected in a retention tank beneath the kill floor, with storage capacity varying from plant to plant. Water is used for the scalding, chilling, dehairing, defeathering, washing and rinsing of carcasses, and the cleaning of processing equipment. To develop standards specific to land applied washwater, there is a need to better understand the quality of the washwater. There has been some research completed to characterize the washwater from meat plant operations, however most of the data has been generated from large-scale operations and does not include all the parameters required to determine the suitability of the materials for land application. Therefore, the objective of this study involved collecting information representative of the meat industry, relative to disposal and storage of meat plant washwater, blood separation and washwater handling practices. The *Food Safety & Quality Act, 2001*, is a legislation enacted in Ontario and administered by the Ontario Ministry of Agriculture, Food & Rural Affairs (OMAFRA). All slaughter operations that are not federally registered must be licensed under this act. There were 184 slaughter plants and 60 free standing meat plants licensed under this act as of January 23, 2006. Meat plants can be slaughtering and processing meat and meat products and classified into – red meat plant and white meat plant. Typically, red meat includes meat and meat products produced from domestically raised animals such as beef, pork, sheep, lamb, goat, rabbit, emu, deer and elk. Meat and meat products produced from domestically raised chicken, turkey, duck and goose are classified as white meat.

Material and methods

A survey was conducted to determine meat plant washwater disposal practices. Meat plant wastewater samples were collected based on the type(s) of species slaughtered and operation. The categories of operations included: (i) beef slaughter only, (ii) hog slaughter only, (iii) poultry slaughter only, (iv) sheep and goat slaughter, and (v) mixed operation, slaughters several species. Sampling sites were chosen based on the questionnaires completed in the profile component of the study. A minimum of 3 samples, each from different days of operations were collected from 6 plants for each category of operation. All washwater samples were collected at the end of the processing operation. Characterization of the meat plant wastewater samples was performed by analyzed for COD (chemical oxygen demand), BOD, TS, TKN, ammonia, ammonium nitrogen, nitrite, nitrate nitrogen, total phosphorus (TP), potassium, sodium, pH, electrical conductivity (EC), the 11 metals specified in the Ontario regulations (OMAFRA 1996), and FOG (fat, oil and grease).

The questionnaire included information such as species of animals slaughtered, average yearly slaughter rates, wastewater storage methods and holding capacity, methods currently used to handle wastewater, frequency of removal (if hauled), quantity of wastewater generally removed, the name of the hauler and the method of final disposal by the hauler. 190 survey questionnaires were sent out to effective abattoirs operating under the *Meat Inspection Act (Ontario)* on May 27, 2003. Up to August 01, 2003, a total of 136 surveys (70%) had been completed. 65% of poultry responded compared to 72% of red meat abattoirs. There were 8 beef, 10 pork, 22 poultry, 2 sheep and 2 rabbit abattoirs. The remaining 92 were slaughtering a mixture of various animals and birds. The 112 responses from red meat plants indicated slaughter numbers to be between 50 and 9,000 animals, with 63% slaughtering under 200 animals per month. The 22 poultry only

responses slaughtered between 1,000 and 550,000 birds per month, with 60% of those slaughtering over 10,000 birds.

When blood is collected during slaughtering, it reduces the BOD_5 and has the potential to reduce odour from the washwater. 62% abattoirs collected blood separately; 11 composted blood on the premises. The remaining 51 plants (38%) did not collect blood separately and allowed the blood to run into the drains. 36 plants have settling tanks that are pumped or skimmed out by renderers. This type of operation was more common in poultry slaughter plants. 2 out of 136 plants surveyed utilized grease trap for fat separation. Out of the 136 plants, 53% of them did not treat their washwater prior to disposal. 16% used treatment systems such as dissolved air floatation or aeration. The remaining 31% of the kill plants utilized passive treatment systems such as storage tank or lagoon to settle out the solids. The sizes of these tanks varied from 3,000 to 750,000 L.

Nine percent were directly connected to municipal sewage treatment plant (STP) and 6% of them haul the washwater to STP. 11% used leaching bed for the disposal of the washwater. An additional 21% used both the leaching bed and haulers to dispose of the washwater. 43% land applied the washwater. Of the 43% that land applied, 33% of them used hauler to land apply the washwater. Close to half that land applied the washwater, stored the washwater for no more than 1 month prior to land application.

The samples were sent to the Ontario Ministry of the Environment (OME) laboratory for analysis. Validated methods were used for the analyses. ANOVA with GLM procedure was used for analysis of data and the ranking of means was done using Duncan's procedure of Statistical Analysis System version 9.1 (SAS 2006).

Results and discussion

There were 224 washwater samples taken from provincially licensed meat plants from 2004 to 2005. The overall results are shown in Table 1.

Parameters	**No. of samples analyzed and reported**	**Mean**	**Standard deviation**
pH (mg/L)	220	6.98	0.63
BOD (mg/L)	219	4635	6114
COD (mg/L)	217	11588	30103
TS (mg/L)	218	6394	6625
EC (mS/cm)	182	5662	4451
Nitrogen - nitrite & nitrate (mg/L)	157	8.59	66.94
Nitrogen – ammonia & ammonium (mg/L)	193	63.66	85.87
TKN (mg/L)	219	841	958
TP (mg/L)	220	48.4	61.9
P_2O_5 (mg/L)	191	21.4	25.2
K (mg/L)	218	91.1	90.7
Ca (mg/L)	218	66.9	60.8
Mg (mg/L)	218	31.8	52.2
Na (mg/L)	218	621.0	1443.7
FOG (mg/L)	220	1302	3282
As (mg/L)	220	0.0252	0.00255
Cd/Co/Hg (mg/L)	205/208/131	< MDL	< MDL
Cr (mg/L)	210	0.21807	0.13588
Cu (mg/L)	217	0.41	0.69
Pb (mg/L)	208	0.21	0.08
Mo (mg/L)	209	0.13	0.18
Ni (mg/L)	207	0.21	0.07
Se (mg/L)	220	0.03	0.00
Zn (mg/L)	220	1.22	2.54

MDL = minimum detection limit

Based on the ANOVA, the meat type had a highly significant impact on the BOD, TKN, and TS and a significant impact on the Cr, ammonia and ammonium nitrogen, TP, K and EC. The presence of blood had a highly significant impact on the BOD, TKN, K and TS and a significant impact on Co, Mo, and TP. The commodity type had a significant impact on the BOD, ammonia and ammonium nitrogen, TKN, TS, EC and Na. The sample spot had a highly significant impact on the nitrite nitrogen and nitrate nitrogen, and K and a significant impact on the pH.

The pH was highly affected by the amount of chemicals used for cleaning and it was also affected by water usage. The age of the washwater varied at these locations. The BOD values reported from previous studies ranged 199-4633 mg/L (Mittal 2003). Applying high BOD materials on land surface may cause odour problems. The legislation in Ontario has not established a guideline for the acceptable BOD levels for material to be land applied. However, the issue of odour as a nuisance is addressed under the *Environmental Protection Act*. The meat type and the presence of blood had a significant impact on the COD. The COD/BOD ratios of washwater with blood were higher than the COD/BOD ratios of washwater without blood. It was caused by higher BOD level in washwater with blood than washwater without blood. The mean COD/BOD ratios from all washwater samples were 2.88 and 2.04, respectively. Reduction of TS and BOD will reduce odour. Hence, the separation of blood and improved handling of offal and manure are highly recommended for meat plants that land apply the washwater.

The EC provides information on soluble salts such as K, Mg, Ca, and Na. MOE restrict the use of washwater for irrigation when the EC is >700 mS/cm. Land application of high sodium washwater is permitted only if the soil sodium and soil EC are monitored annually. Only 5 washwater samples had EC values less than 1000 mS/cm. The amount of phosphate phosphorus was not affected by the meat type, the presence of blood, the sample spot or the commodity type. The meat type had a significant impact on Cr level.

The results obtained from this study fall within the range of the results obtained from other studies in other jurisdictions (Mittal, 2003). As the TKN and the BOD can be decreased by the reduction of TS in the washwater, it is important that the meat plants remove as much total solids from the washwater as possible. These solids contain meat scraps, intestinal contents, manure, hair and dirt, and they can be easy removed by using a mechanical separation device such as a filter or screen. It can also be achieved by using best management practice where solids such as manure should be removed from the floor before water is used to wash the meat plant. The meat scraps can be disposed of by rendering, composting, burial or incineration instead of land application. This will reduce the odour and the impact on the environment.

Since no meat tissue samples were taken when the washwater samples were taken, it can not conclusively suggest that meat tissues contained any metals. Metals found in the washwater could be caused by the other environmental factors suggested earlier. In the case of meat plant washwater, the concentration of metals present is very low. Land application of meat plant washwater is a common practice by meat plant operators. Several larger meat plants have approvals from the MOE to land apply the washwater on agricultural land. If the washwater is land applied properly, the risk to the environment is minimal.

There are concerns about the presence of pathogenic microorganisms in meat plant washwater. There are also concerns about the odour that may be generated from land applying meat plant washwater. These two topics should be further investigated and quantified. Further studies should also be done to evaluate the performance and economic impact of various types of washwater treatment methods.

References

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