Composition of Pig Manures and Wastewaters under the Gan Qing Fen System in China

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Abstract: A large scale pig farm located in the North West of Beijing that applies the gan qing fen manure management system was selected and a continuous sampling of manures and wastewaters was performed from June to October 2009. Samples were collected once a week based on the pig production cycle, namely gestation, farrowing, weaning and fattening. Analysis of nutrients and heavy metals were determined by means of Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP). Total Nitrogen (TN) was determined by the Kjeldahl method. The main results showed that pig manures were characterized by high nutrients and heavy metals contents that might be due to the solid fraction separation from the liquid fraction under the gan qing fen manure management system. Further, piggery wastewaters were characterized by very low concentrations of nutrients and heavy metals as result of their dilution with flushing water mainly used for cleaning the pigsties. Manure and wastewaters samples from weaning pigs contained the highest concentrations of nutrients and heavy metals that could be due to high supplementation rates of these minerals in the weaner diets. In general, it seems that the manual daily collection of pig manures in the gan qing fen system is an efficient practice in order to maintain nutrient contents in pig manures but the use of flushing water should be reduced as it can lead to further environmental pollution.

Keywords: China, gan qing fen, manure, wastewater, pig farm.

1. Introduction

China is the world’s largest consumer of livestock meat products and Chinese farmers produce 50% of the global production of slaughtered pigs. Livestock production in peri urban areas is dominating in China and pig farming has been decoupled from crop farming [1]. Intensive pig farming is positioning China as one of the largest producers of animal manure in the world with an annual output of more than 3 billion tonnes [2]. The manual daily collection of pig manures denominated “gan qing fen” in Chinese or its direct translation in English as “cleaning manure dryly” is an old Chinese farming practice. Gan qing fen is mainly used in large scale animal farms in order to maintain high Nitrogen, Phosphorus and Potassium nutrient contents in manure for compost production. Following the gan qing fen system, two main fractions are generated through the collection system, i.e. manures (solid fraction) and piggery wastewaters (liquid fraction) [3]. A few descriptive studies about nutrients and heavy metals concentrations in pig manures and wastewaters from gan qing fen manure management are published in Chinese language and hence not broadly reported. Likewise, several previous studies do not offer information about the manure management practiced during their research, making difficult the use of those results for comparisons with the data obtained from the gan qing fen manurai system. Therefore, in this research an intensive pig farm from peri urban Beijing was studied in order to analyze the
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concentrations of main nutrients and heavy metals in their pig manures and wastewaters under the gan qing fen manurial collection system.

2. Materials and Methods

This study was performed on a commercial pig farm located in the North West of Beijing, China. The pig farm has an annual stock of ca. 15,000 pig heads and it is composed by 56 pig barns with an average capacity of 200-300 pigs each one. Pig barns are distributed following the main pig cycles, i.e. gestation, farrowing, weaning and fattening.

For this study, 4 pig barns were selected, each one in every pig cycle. A sampling plan was set from June to October 2009 (summer season). Each week samples of pig manures and wastewaters were collected inside the pig barns before emptying the solid and liquid manure from the pigsites with the traditional gan qing fen management system. Samples were stored in a cooler and lately were transported for chemical analysis to the labs of the China Agricultural University, Beijing.

Determination of Phosphorus (P), Potassium (K), Zinc (Zn), Copper (Cu), Cadmium (Cd), Lead (Pb) and Chromium (Cr) were achieved through the use of Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP) technology. Determination of Total Kjeldahl Nitrogen (TN) was performed by means of the Kjeldahl method. All the results are shown on wet weight basis or as sampled (wb). International Standard methods were used in the samples analysis [4, 5]. Statistical descriptive analysis was performed in the manures and wastewaters from each pig growing stage using the software OriginPro, 8.5G Student Version.

3. Results and Discussion

Figs. 1 and 2 show the main results obtained for TN, P and K contents in pig manures and wastewaters. TN contents from 6 to 16 g/kg were found in all the pig manures. The highest contents of TN (16.48 g/kg) and K (6.76 g/kg) were found in pig manures from weaning pigs while the highest values of P were found in manures from farrowing pigs (12.60 g/kg). Results in western countries, showed slightly different values of TN from 3.5 to 12 g/kg, mean values of P of 2.5 g/kg and mean values of K of 4.79 g/kg for pig manures [3, 6]. It seems that under the gan qing fen system, high nutrient amounts can be maintained in the manures as result of their separation from the liquid wastes before pig pen’s floors are flushed with water. Besides, piggery wastewaters showed very low nutrient contents, indeed, less than 4 g/kg of TN, less than 1.8 g/kg of K and less than 0.43 g/kg of P were found in all the piggery wastewaters that reflect the large amounts of water used to flush the pig floors and to cool pigs especially during the summer season.

Figs. 2-4 show the main results obtained for heavy metals contents in pig manures and wastewaters. Concentrations of heavy metals in pig manures can be ranked in the following order, Zn > Cu > Cr > Pb > Cd, while concentrations of heavy metals in piggery wastewaters can be ranked as Zn > Cu > Pb > Cr > Cd. Similar distribution of heavy metals were found in pig manures from China, UK and Australia [7-10]. Zn was the heavy metal with the main presence in all the manure and wastewater samples which may reflect its addition to pig diets as similarly found in a study in the UK [11]. The highest values of Zn were found in manures from weaning pigs (169.33 mg/kg) representing almost 7 times the mean contents of Zn found in the fattening pig manures (24.91 mg/kg). The average content of Cu in manures were very low compared with a study performed in Beijing, in which Cu was found to be ca. 10 times higher than the values obtained in this study [12]; this can be a result of the low Cu supplementation in the pig feeds in the pig farm under research. The highest concentrations of Cd (0.76 mg/kg), Pb (3.67 mg/kg) and Cr (10.35 mg/kg) were mainly found in manures from weaning pigs. Cd contents in this study were very similar to those found in pig manures from Jiangsu [7]. In overall, all the wastewater samples showed very low heavy metals concentrations as expected under the gan qing fen collection method.
Fig. 1  TN and P contents (wb) found in pig manures and wastewaters.

Fig. 2  K and Cu contents (wb) found in pig manures and wastewaters.

Fig. 3  Zn and Cd contents (wb) found in pig manures and wastewaters.
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4. Conclusions

Pig solid manures were characterized by high nutrients and heavy metals contents that might be result of the solid fraction separation from the liquid fraction under the gan qing fen manure management system. Further, piggery wastewaters were characterized by very low concentrations of nutrients and heavy metals as result of their dilution when using water for cleaning the pigsties and for cooling the pigs. Manure and wastewaters samples from weaning pigs contained the highest concentrations of nutrients and heavy metals that could be due to high supplementation rates of these minerals in the weaner diets. In general, it seems that the daily collection of pig manures or gan qing fen is an efficient practice in order to maintain the nutrient contents in pig manures, however, dilution of nutrients and heavy metals in the pig wastewaters by the use of flushing water is not a solution for environmental pollution.

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