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Characterization of fertilized liquid manure and pollution load at different pig farms in South Korea

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Abstract

Since the ocean dumping was banned in Korea in 2012, Korea government focuses on disposal of manure discharge in animal farms. Domestic animal manure can provide nutrients for crop cultivation and input for biogas production but, if managed in appropriately, can also have a negative impact on the environment. Due to the high pig concentrations and high off-farm disposal costs, on-farm treatment facility has been increased rapidly in Korea. Most of farms are used aeration treatment system while some of them are used with return activated sludge (RAS) treatment system. The objectives of the study were to provide information pig manure management practices and characterization of treated fertilized liquid manure (FLM) at different farms. Accordingly, FLM was subjected to analyze BOD, T-N, T-P, NO_3-N, PO_4-P, TSS, and NH_3-N. BOD value in FLM produced from RAS enhanced farm was in a range between 265-1,945 mg/L with an average value of 1,006 mg/L, while the average BOD of aeration treated farms was 13,475 mg/L. This value is thirteen times higher than the RAS farms. In case of T-P, TSS and NH3-N, the concentrations obtained were much lower in RAS treatment system than the aeration only. Based on the analysis results, 1,226 ton/ha/yr and 2,970 ton/ha/yr of FLM from RAS farms and aeration farms, respectively, are needed to meet the equivalent amount of nutrient NO_3 (9kg/ha/yr) for rice production. Of the investigated farms, animal farms which have the RAS treatment facility provided the better quality of FLM than ones have aeration treatment facility.

Keywords—fertilized liquid manure; pig manure; return activated sludge; treatment system

Introduction

According to London Dumping Convention Act' 1975, ocean dumping was banned in 2012 in Korea. Therefore, produced Domestic animal manure has been treated sincerely these days. Also Korea government actively focuses on treated manure discharge from the farms to environment in terms of pollution load as well as Korean animal manure in farms and public facilities to stop the ocean disposal. Thus producing chemical fertilizer has been reduced day by day instead the eco-friendly, government encourage to resource recovery of domestic bio-manure production has increased and being popular in Korea. Emission of animal manure is 0.6% of total pollution of wastewater; including fertilized liquid manure (FLM) which has high concentration of nitrogen and phosphorus that occurred eutrophication in the lake. The characterization of domestic animal manure depends on the type of animal, weight, feeding, breeding way, drinking amount, season, etc. But most of manure produced by pig, about 42% of total domestic animal manure. So in this study mainly use pig manure.

The conventional method of resource recovery from the pig manure is solid-liquid separation and then the solid matrix is mixed with rice hulls or sawdust, and the liquid manure is treated with aeration for ripen to be good fertilizer. Another method to use of liquid manure is anaerobic digestion to produce the methane gas.

In this study, we focused on the characterization of pig manure and resource recovery in the farm. We also given a special attention on nitrogen and phosphorus since these compounds are responsible for eutrophication. Also, the characterization of FLM treated by return activated sludge (RAS) and aeration process was compared.

Materials and Method

Sampling site

Samples were collected from different pig farms in Jeolla-namdo in Korea, twice in a year in July and October 2013. Samples were collected using a 1 L sterilization water bottle and kept in refrigerator at 4 °C before use.

Analytical method

BOD (Biochemical Oxygen Demand), T-N (Total Nitrogen-UV/Visible Spectrometry- Oxidation Method), T-P (Total Phosphorus- UV/Visible Spectrometry), NO_3-N and PO_4-P (Anions-Ion Chromatography) were analyzed according to the Korea Standard Test Method, . and NH_3-N (4500-Ammonia) and TSS (2540-Solid) were subjected to APHA standard methods

FLM	BOD	TSS	T-N	NH_3-N	NO_3-N	T-P	PO_4-P
Max	26121	26050	5398	3143	60	545	617
Min	811	383	1544	135	4.5	87	47
Avr.	11421	6059	3372	1587	33	192	218

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TABLE 2. CHARACTERIZATION OF FLM TREATED BY RAS SYSTEM (UNIT: MG/L).

Farm	BOD	TSS	T-N	NH_3-N	NO_3-N	T-P	PO_4-P
Y 1-1	1945	1100	1543.7	610.2	60.2	91.9	63.9
Y 1-2	265	933.3	4250.3	448.7	106.2	84.2	69.8
Y 1-3	810.5	383.3	3354.8	135.1	53.7	87.1	187.7
Average	1006.8	805.5	3049.6	398	73.4	87.8	107.1

TABLE 1. CHARACTERIZATION OF FLM OF DIFFERENT PIG FARMS' SAMPLES (UNIT: MG/L).

Result and Discussion

Table 1 shows the FLM characterization. Table 2 and 3 show the characterization of FLM treated by RAS and aeration system, respectively.

Farm, namely, Y 1-1 and Y 1-2 were used 3M-system and Y 1-3 was used ONE-system and each system consists with different microorganisms and RAS system for decomposing harmful matter(Table 2). Other farms were used aeration treatment system for producing the FLM(Table 3).

The specific microorganism was sprinkled in pigsty in both 3M-system and ONE-system farms which decomposed manure and the wash the pigsty and kept in a storage tank where the microbial decomposition occurred for 2~3 days. After that 50% of FLM was used to farmland as a fertilizer and other was return to a pigsty. The returned activated sludge which has activated microorganisms that could easily decompose the harmful matter while the manures generate concurrently. Advantage of this farm system is microorganisms can adapt each farm's environmental condition during 2-3 months. After that microorganism enhanced activate sludge can decompose more easily and can reduce BOD, TSS and offensive odor from NH_3-N.

BOD value in FLM produced from RAS enhanced farm was in a range between 265-1,945 mg/L with an average value of 1,006 mg/L, while the average BOD of aeration treated farms was 13,475 mg/L. This value is thirteen times higher than the RAS farms probably due to the poor microbial degradation. T-N value in FLM produced from RAS enhanced farm was in a range between 1,543-4,250 mg/L with an average value of 3,049 mg/L, while the average T-N of aeration treated farms was 3,736 mg/L. This value is slimier to the RAS farms. T-P value in FLM produced from RAS enhanced farm was in a range between 84-91 mg/L with an average value of 87.8 mg/L, while the average T-P of aeration treated farms was 213 mg/L. This value is around two and half times higher than the RAS farms. In this study, plant available nitrogen and phosphorus compound were found to be NO_3 and PO_4, respectively. Based on rice production nutrient availability, 9 kg/ha/yr and 4.5 kg/1ha/yr of NO_3 and PO_4 are needed, respectively, but these values can vary with plant species. 1,226 ton/ha/yr and 2,970 ton/ha/yr of FLM from RAS farms and aeration farms, respectively, are needed to meet the equivalent amount of NO_3. When FLM to be sprinkled to farmland, it can be assumed that converted BOD and other nutrients will load to eco-system. In this study, the converted BOD was calculated to be 1,234 and 40,027 ton/ha/yr, when using the FLM from RAS and aeration farms, respectively. It's clearly thirty two times higher loading for aeration based FLM, thus this system is greatly responsible for heavy load to the water environment. Also, TN and TP was relatively lower in RAS based FLM than aeration based FLM, which can guess less effect to eutrophication.

In case of TSS value, TSS value in FLM produced from RAS enhanced farm was in a range between 383-1,100 mg/L with an average value of 805 mg/L, while the average TSS of aeration treated farms was

TABLE 3. CHARACTERIZATION OF FLM TREATED BY AERATION SYSTEM AT DIFFERENT PIG FARMS (UNIT: MG/L).

Farm	BOD	TSS	T-N	NH_3-N	NO_3-N	T-P	PO_4-P
Y 2-1	15487.5	4800.0	2617.3	1021.7	54.8	105.4	92.5
Y 2-2	18400.0	9550.0	5064.0	1398.1	39.2	252.8	525.0
Y 2-3	14791.6	14083.3	2867.9	1311.4	26.8	210.4	437.0
Y 2-4	2641.6	1883.3	2215.0	3595.8	38.6	117.3	135.8
Y 2-5	18229.1	5033.3	5663.9	7297	47.3	296.9	138.4
Y 2-6	9566.6	3500	3077.0	3143.4	56.1	115.4	190.1
Y 2-7	17483.3	2200	4202.9	1425.4	20.3	129.3	92.6
Y 2-8	10983.3	6250	3077.6	1498.8	19.5	152.3	68.2
Y 2-9	26120.8	2931.8	5398.3	1604.0	14.9	243.8	195.4
Y 2-10	3664.1	2768.1	2698.5	1902.7	21.3	140.3	47.1
Y 2-11	2254.3	2758.3	2641.5	2462.0	19.7	247.5	251.4
Y 2-12	22087.5	26050	5316.0	2256.3	4.4	545.1	617.2
Average	13475.8	6817.3	3736.7	2409.7	30.3	213.0	232.6

6,817 mg/L. This value is eight times higher than the RAS farms. As detailed above, aeration based FLM is not suitable to be sprinkled because it will deposited high amount of TSS in water which can lead to block normal water flow and make high cost in water treatment. NH_3-N value in FLM produced from RAS enhanced farm was in a range between 135-610 mg/L with an average value of 398 mg/L, while the average NH_3-N of aeration treated farms was 2,409 mg/L. This value is six times higher than the RAS farms.

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- Master course student.
-Treatment technique for contaminant by heavy metal.
-Fertilize method for better quality fertilizer.

Conclusion

In this study, we compared the characterization of produced FLM by two different treatment systems at different pig farms and evaluated the pollution load to the water environment for the RAS and aeration based FLM. RAS based FLM is preferable to use to the farmland since it makes better quality fertilizer and get less pollution load to the environment.

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