ISSN : 0974 - 7435 Volume 10 Issue 18

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(18), 2014 [10688-10692]

Study on livestock and poultry excrement pollution prevention and resource to cultivation microalgae

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ABSTRACT

The pollution produced by the excrement of livestock and poultry is becoming more and more prominent and the dejection of domestic animals must be rationally treated and utilized. The anaerobic fermentation is an important pollution control technology, however, it also may produce many biogas slurry and residues and very likely leads to the secondary pollution especially when there is no proper treatment. Biogas slurry is used as a microalgae growth medium which could obtain bio-diesel and purifies biogas slurry, therefore, it can achieve not only effective environmental protection but also waste reduction, hazardless and efficient utilization. The authors's experimental results showed that Chlorella vulgaris can grow advantageously in the swine wastewater environment and the utilization of pig wastewater to culture microalgae can achieve the goal of piggery wastewater's purification.

KEYWORDS

Livestock and poultry excrement; Pollution; Biogas slurry; Microalgae; Piggery wastewater; *Chlorella vulgaris.*

INTRODUCTION

Recently in China, the preferential policies about supporting the development of livestock and poultry breeding are promulgated, and breeding industry has obtained a rapid development[1]. However, the subsequent problems of pollution from livestock and poultry breeding are becoming increasingly serious. Moreover, there is no full equipment for pollution treatment in many large-scale livestock and poultry farms, and the comprehensive utilization rate also is low.

It was found that the main ingredients of livestock and poultry dejecta are as follows. Main content in dung are hemicellulose, cellulose, proteins, lignin, organic acid, fatty acid and inorganic salts; main content in urine are uric acid, urea, hippuric acid and sodium, potassium, magnesium, calcium and other water soluble inorganic salts[1]. Given all that, if rural livestock and poultry feces are misplaced, it will cause great harm to surrounding environment, including soil, water, atmosphere and so on.

RESEARCH CONTENT

The pollution and harm of livestock and poultry dejecta

Being of strong eluviation, dejecta can pollute surface water and groundwater through surface runoff. According to the monitoring analysis from environmental protecting department, compared with the Chinese sewage discharge standard, the chemical oxygen demand (COD) of pig farm sewage exceeds the standard 53 times, and its five days biochemical oxygen demand (BOD_5) exceeds the standard 76 times, the suspended solids (SS) also exceeds the standard 14 times, and the pollution index Pij of the above-mentioned three comprehensive index is 63.61, which reached the standard of serious pollution. Furthermore, feed which containing nitrogen and phosphorus is usually used in livestock and poultry breeding, but animals hardly can assimilate the nutriment of nitrogen and phosphorus, thus large quantities of nitrogen and phosphorus go into the environment with animals' excretion, which then may pollute groundwater and surface water through the surface runoff, and finally cause water eutrophication.

At present, "dung fertile", namely, applying dejecta without any treatment directly as fertilizer, still is the main way to dispose of manure for farmers. However, feed often contain high doses of phosphorus, copper and other trace elements. Without digestion and absorption, some trace elements The air pollution of livestock and poultry farms includes odor, dust and microorganism. Due to organic matter decomposition, fermentation and corruption, in the stacking process, dejecta can produce highly volatile odorous substance including methane, ammonia, hydrogen sulfide, organic acids, alcohols and so on, which have irritant and toxic effects on human and animal . In addition, the volatilized methane can contribute to greenhouse effect.

will be left over excretion, and are overly enriched in soil, resulting in environmental pollution and poisoning effects on crops.

Feeds manufacturers are likely to add some illegal and harmful substances in the producing process. Those sustances, along with misusing antibiotics, hormones, lead to various types of toxic and harmful residues in livestock and poultry products. When human eat these products, residues directly enter into the human body, then may cause toxic and allergic reaction and other serious harm to human's health. At the same time, there are lots of pathogenic microorganisms and parasites in dejecta. Without timely treatment, it may breed flies and mosquitoes, which result in pathogens and parasites, especially zoonosis, being overspread and then produce harmful effects on human's health.

The pollution control of dejecta

First, the legal system of prevention along with strict law enforcement should be improved.

Government should step up its environmental monitoring efforts and perfect"measures controlling pollution of livestock and improving poultry breeding management", as well as strictly prohibit the illegal discharge. Furthermore, it is necessary to regulate feed manufacturing industry and strictly limit hormones and other additives in feed production and usage.

Second, the biogas biological treatment technology should be applicated.

With the application of biotechnology, firedamp pools should be built and the livestock and poultry excrement also should be rationally utilized. The livestock and poultry dejecta is fermented to produce biogas, which can effectively reduce the pollution from livestock and poultry manure to water body, farm land and air . The biogas slurry can also be used as a kind of organic fertilizer, which can reduce common fertilizer and pesticide using and reduce pollution during farming process.

Third, using livestock and poultry waste to cultivate energy microalgae.

Today, with the increasingly serious environmental pollution and gradual depletion of fossil energy, the exploitation of new energy sources and turning waste biomass into available chemical energy is growingly concerned[2-4]. Biodiesel, as a renewable and alternative energy, has been paid more and more attention. Biodiesel is the renewable diesel fuel that made from ester exchange process which take the animal and vegetable oil as raw material and can replace the fossil diesel[5-7].

Microalgae is a class of single cell algae with fast cell proliferation but short production cycle. It would not be affected by the seasons and land; moreover, its culture medium could be rich. The process of microalgae cultivation can utilize N, P and other nutrition in waste to produce a kind of grease being similar to vegetable oil. Microalgae in individual is small, easily crushing and drying, and its lignin content is very low. Therefore, people have increasingly favored using of

microalgae to develop oil resources, and microalgae also is considered to be the most potential feedstock for biodiesel. Nevertheless, one of the core issues about using of microalgae to produce oil is that the production costs are too high. Thus, how to reduce the cost of culture medium is the key of reducing microalgae diesel production cost[8].

The organic and inorganic salts in biogas slurry are good nutrition for algae. Taking biogas fermentation liquid as the source of nutrition to culture microalgae, not only can save microalgae biodiesel production costs, produce clean and renewable energy biogas and raw material of microalgae biodiesel, but also can treat a large quantity of nitrogen, phosphorus in the biogas slurry, prevent and control water environmental pollution, thus achieve energy-saving and emission reduction, meanwhile promote its economic, social and ecological benefits.

Other countries, especially the United States, had begun to study how to make use of microalgae to prepare biodiesel since the nineteen seventies. In China, the studying with microalgae to prepare biodiesel has been more than 20 years, and is mainly directed against the green algae, especially on *Chlorella*.

Wang Cui et al[9] studied the Chlorella growth in biogas slurry of different concentration rates (25%, 50%, 75% and 100%) and lipid accumulation . The results showed that the *Chlorella* could grow well in biogas slurry of low concentration rates (25%, 50%) and delayed for a shorter period, while in biogas slurry of high concentration rates (75%,100%), delay period was longer. The cultured *Chlorella* total fat content was the highest in the biogas slurry of 50% concentration rate.

Canizares[10] studied the culture condition of *Spirulina platensis* with pig manure. The results showed that the PO_4^{3-}-P, TP and NH_4^+-N removal rates reached 98%, 53% and 75% respectively, and the total biomass upped to the maximum at the sixth days

Chang et al[11] with the piggery wastewater and primary-treated sewage to cultured the green alga *Haematococcus pluvialis*. The research results showed that the algae cells growth was the same in 4 times diluted wastewater as in ordinary medium on conditions that only provided carbon dioxide mixture gas and light, and the astaxanthin content achieved respectively 5.1% and 5.9% of dry cell weight, at the same time, the phosphorus and nitrogen also were properly disposed of .

Elizabeth et al[12] studied how different wastewater dosage's effects on nutrient removal and microalgae growth rates, as well as the composition of microalgae when using microalgae to treat pig manure wastewater. The results showed that nitrogen and phosphorus removal rate reached over 90% and 68%～78% respectively, microalgae growth was 9.4g/(m^2·d) when the wastewater dosage was 0.40L/(m^2·d).

The urgent key technologies of microalgae cultivation with livestock biogas slurry

How to choose the energy algae species which are suitable for livestock biogas slurry, the coupling techniques between energy microalgae and livestock biogas slurry during the cultivation process, and the treatment technology development of the wastewater produced by microalgae biodiesel production, the development of large-scale and low-cost microalgae harvesting technology, the optimization and standardization methods of culturing process of energy microalgae in biogas slurry, all these themes mentioned above are the urgent and key technologies of cultivation microalgae with livestock biogas slurry.

RESULT AND DISSCUSS

The authors collected the biogas slurry from a pig farm to cultivated *Chlorella vulgaris*, the wastewater quality of the biogas slurry was showed in tab1. The *Chlorella vulgaris* is unicellular green algae, belonging to the *Chlorella Beijerinck* of *Chlorophyta*. Which is spherical in shape, without flagella, about 2 to 10 μm in diameter[13]. After 7 days, the color of the training sample changed into dark green, and a lot of *Chlorella vulgaris* cells could be observed under a microscope. The morphology of *Chlorella vulgaris* training in the conical flask and under the microscope were shown in Figure 1.

The *Chlorella vulgaris* growth was monitored through calculation number of algal cells per day with a microscope and XB - K - 25 type blood count plate, and then converted the algal cells to the culture aglal density. According to the test results, the algae growth curve was drew and shown in Figure 2.

At the same time, our experimental results also showed that the piggery wastewater could been purified, as shown in TABLE 1, the CODcr, TP, NH^{4+}-N removal rates were 56.7%, 78.1% and 84.5% respectively at the twelfth day.

Above all of our experimental results showed that *Chlorella vulgaris* has strong stain resistant ability and impact resistant ability; thus, it can grow advantageously in the swine wastewater environment. The study also proved that the utilization of pig wastewater to culture microalgae can achieve the goal of piggery wastewater's purification.

TABLE 1 : The variety of piggery wastewater quality between pre and post reutilization to cultivate Chlorella vulgaris

	CODcr (mg/L)	TP (mg/L)	NH^{4+}-N (mg/L)	pH
Pre	1935	105	850	6.75
Post	837	23	132	9.04
Removal efficiency	56.7%	78.1%	84.5%	/

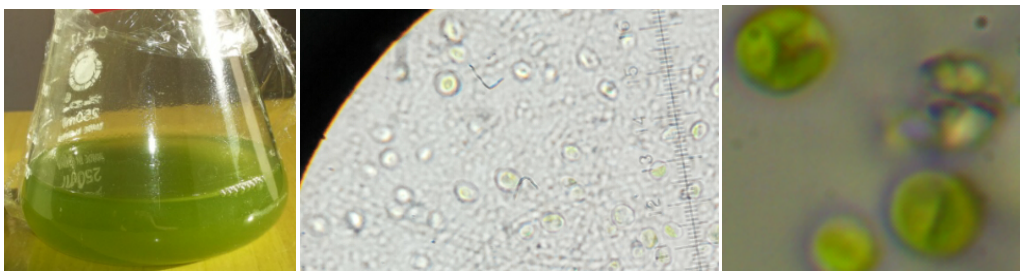

Figure 1 : The *chlorella vulgaris* training in the conical flask and under the microscope

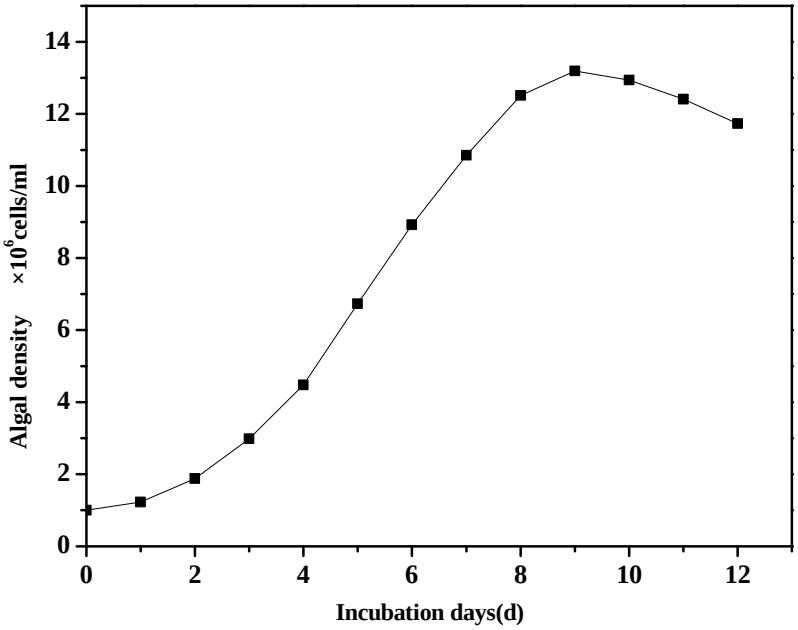

Figure 2 : Growth curves of chlorella vulgaris cultures

CONCLUSION

Given that China's construction of countryside and the harmonious society has been accelerating, we should promote the pollution control over stockbreeding, especially in the aspect of the rational management and utilization of livestock and poultry manure. The direct utilization of cultivating microalgae with livestock biogas slurry and the subsequent production of microalgae biodiesel can not only effectively protect environment, but also achieve waste reduction, as well as a harmless, high efficient resourcing, then really promote the economic, social and ecological benefits of the technology.

ACKNOWLEDGEMENT

This research was supported by the Jiangxi Provincial Department of Science and Technology Programs for Science and Technology Development (Project No: 20121BBF60052 and 20132BAB203024), China. The work was supported by the Open Fund (Project No: 13005875 and 13005874) from Key Lab of Poyang Lake Environment and Resource Utilization, Ministry of Education, Nanchang University, China. This study was also Supported by National Natural Science Foundation of China with Grant (Project No: 41261097 and 51209115). The authors greatly appreciate the editor and the anonymous reviewers for their insightful comments and suggestions.

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