How to Comprehensively Utilize the Discarded Fresh Tobacco Leaf ?

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Abstract This paper aims to explore comprehensive utilization way of discarded fresh tobacco leaf. Based on modern tobacco demands on green, environmental protection and sustainable development, as well as actual situation of biogas production facility in some villages of local tobacco area, this paper selects Longwan Village of Fengshiyan Town as the experimental site and explores the rational way of discarded fresh tobacco leaf biogas fermentation. Results show that cutting and fermentation of discarded fresh tobacco leaf before adding into biogas digester is conductive to improving pH in fermentation process, reducing crust amount, and effectively improving biogas production amount and rate. The study can provide reference for effective processing and rational utilization of discarded fresh tobacco leaf.

Key words Discarded fresh tobacco leaf, Biogas fermentation, Comprehensive utilization

1 Introduction

In recent years, with the increasing growing area of tobacco leaf in Qidong County of Hunan Province, frequent occurrence of tobacco plant diseases and implementation of guideline "optimizing tobacco structure and destroying some underdeveloped leaves in the upper part and malnourished leaves in the lower part" issued by the State Tobacco Monopoly Administration, the amount of discarded fresh tobacco leaves is increasing in the tobacco field. Studies have shown that in the tobacco harvest process, it will produce approximately 5% of secondary tobacco leaves[1]. In production, influenced by the traditional extensive agricultural production patterns and habits, tobacco growers arbitrarily throw away the discarded fresh tobacco leaf, which not only wastes available resources and pollutes environment, but also deviates from the current idea of clean, efficient and sustainable agriculture[2-3]. In addition, the improperly discarded fresh tobacco leaf is bound to become a beneficial parasitic place for a variety of pests, which will become an important transmission source of pests and diseases in tobacco fields in the coming year. Therefore, the effective treatment and rational utilization of discarded fresh tobacco leaf has a practical necessity. Based on modern tobacco demands on green, environmental protection and sustainable development, as well as actual situation of biogas production facility in some villages of local tobacco area, this paper selects Longwan Village of Fengshiyan Town as the experimental site and explores the rational way of discarded fresh tobacco leaf biogas fermentation.

2 Materials and methods

2.1 Materials The experiment is set in Longwan Village, Fengshiyan Town, Qidong County, Hengyang City. The tobacco growing area of this village is about 46.67 ha, and the discarded fresh tobacco leaves are produced by this village. The biogas digester for experiment, built in 2010, is hydraulic, with the volume of 8 m^3.

2.2 Methods

2.2.1 Contrast experiment of discarded fresh tobacco leaf pretreatment. Treatment 1: 500 kg of discarded fresh tobacco leaves without being crushed are mixed with cow dung in 1: 2 proportion to be directly placed into biogas digester. Treatment 2: 500kg of discarded fresh tobacco leaves are crushed and cut into 8 – 10 cm sections, and mixed with cow dung in 1: 2 proportion to be directly put into the biogas digester. Treatment 3: 500kg of discarded fresh tobacco leaves are pulverized and cut into 8 – 10 cm sections, and mixed with cow dung in 1: 2 proportion and water to be wetted and retted for 3d; after the tobacco leaves get brown and are initially rotted, they are put into biogas fermentation tank. Indicator recording: Comparative observation and recording are performed on biogas occurrence and biogas residue crusting. The gas production rate, gas production, dynamic pH changes of biogas slurry and crusting amount of biogas residue are regarded as the recording indicators.

2.2.2 Contrast experiment of inoculum selection. Treatment 1: Cow dung is as the mixing material. Treatment 2: Pig manure is as the mixing material. Treatment 3: Chicken manure is as the mixing material. 500kg of preliminarily crushed discarded fresh tobacco leaves are mixed with the dung of three kinds of livestock in 1: 2 proportion to go through preliminary retting and fermentation for 3d and they are put into biogas digester. Then the gas production rate, gas production and dynamic pH changes are observed and recorded.

3 Results and analysis

3.1 Comparative analysis of discarded fresh tobacco leaf pretreatment

3.1.1 Comparative analysis of gas production and gas production

Received: September 9, 2015 Accepted: November 25, 2015

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rate. In terms of gas production, there is a small difference between Treatment 2 and 3, and the continuous burn time is 117 and 121 h, respectively; the continuous burn time of Treatment 1 is shortest, only 80 h. In terms of gas production rate, it is highest in Treatment 3. On the second day after material input, it begins to produce gas; on the third day after material input, the amount of biogas has reached the combustible standards. For Treatment 2, on the third day after material input, it begins to produce gas, but it is not combustible until the sixth day. In Treatment 3, the gas production is slowest, and the biogas can not reach the combustible level until the eighth day.

3.1.2 pH changes. Fig. 1 shows that after the material is put into biogas digester under three treatments, pH decreases apparently, but there is a big difference in the decline rate. In Treatment 3, on the second day after material input, pH decreases to a minimum, and then increases slowly. In Treatment 1 and 2, on the sixth day, pH decreases to a minimum. There is the biggest drop in Treatment 2, and pH is only 3.5 on the sixth day, showing obvious acidification.

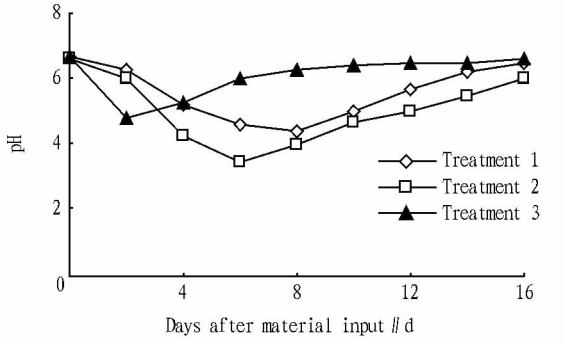

Fig. 1 pH changes

3.1.3 Biogas residue crusting. After the biogas fermentation, biogas slurry is cleared. By comparing the three treatments, the crusting is most unobvious in Treatment 3; there is obvious crusting in Treatment 1, thus affecting the biogas production; the crusting amount is small in Treatment 2.

3.2 Comparative analysis of inoculum selection

3.2.1 Gas production rate and gas production under each treatment. The results show that the production rate of biogas from biogas fermentation by mixing discarded fresh tobacco leaf with cow dung and pig manure is the highest, and it begins to produce gas after material input and reaches the combustible level on the third day after the input. In terms of biogas amount, the continuous burn time of cow dung is 124 h, 15h more than that of pig manure; on the fourth day after the material input, chicken manure can reach the combustible level and the continuous burn time is 120 h. The rate of gas produced by mixing discarded fresh tobacco leaf and chicken manure for biogas fermentation is significantly slower than that of gas produced by mixing discarded fresh tobacco leaf and cow dung, and on the fourth day after the input, the gas produced can reach the combustible level, but the biogas duration is basically the same as that of cow dung. The rate of gas produced by mixing discarded fresh tobacco leaf and pig manure for biogas fermentation is significantly higher than that of gas produced by mixing discarded fresh tobacco leaf and chicken manure, but the gas production is the lowest.

3.2.2 pH changes. Fig. 2 shows that the after material is put into fermentation tank, there is a significant acidification phenomenon, and it reaches the lowest level initially, and then rebounds slowly. The acidification is most significant in the treatment of mixing discarded fresh tobacco leaf with chicken manure, while the acidification in the treatment of mixing discarded fresh tobacco leaf with cow dung is roughly equal to that in the treatment of mixing discarded fresh tobacco leaf with pig manure.

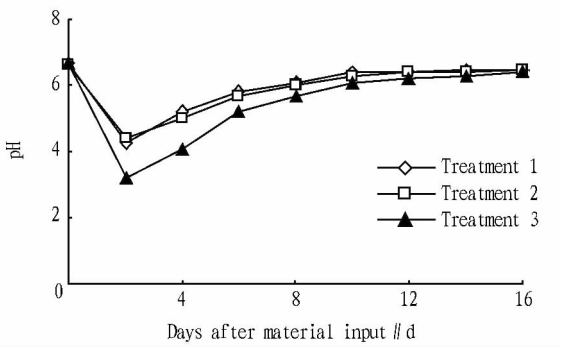

Fig. 2 pH changes

4 Conclusions and discussions

4.1 Conclusions The biogas fermentation is actually the metabolism and energy conversion process of a variety of methane bacteria, and the basic process can be divided into hydrolysis, acidogenic stage methanogenic stage[4-5]. For the discarded fresh tobacco leaf, the hydrolysis is that in the action of fermentation bacteria, complex organic matter is under hydrolysis fermentation and the complex organic matter is converted into simple organic matter. At the acidogenic stage, in the action of acid-producing bacteria, simple organic matter is broken down into organic acid such as acetic acid and butyric acid. At the methanogenic stage, the product at the acidogenic stage continues to be broken down into methane and carbon dioxide.

4.1.1 Benefits of chopping discarded fresh tobacco leaf. The surface of discarded fresh tobacco leaf is covered with a layer of wax, so that it is not easily broken by methane microbes, and if it is directly put into the fermentation tank, there will be a large number of floating crusts. From the pretreatment experimental results about discarded fresh tobacco leaf, it is found that by chopping discarded fresh tobacco leaves, it can prevent fresh tobacco leaf from floating on the surface of biogas slurry and crusting after being put into fermentation tank, thus making the biogas production faster.

4.1.2 Retting fermentation of discarded fresh tobacco outside leaf tank. The process of biogas production by anaerobic fermentation of biogas material is completed by joint action of a variety of methane bacteria, and there is an acidification stage; the activity of methane bacteria is greatly influenced by pH. The retting of

chopped discarded fresh tobacco leaves makes the hydrolysis and acidification occur outside biogas digester, which can reduce the degree of acidification of biogas slurry, and avoid the activity inhibiting of methane bacteria. In the process of retting, it allows the methane bacteria to grow and reproduce in a large number, so that the gas production is faster in biogas digester. In addition, the high temperature generated by humid retting can be up to 70 ℃, kill some bacteria and pests, and partially decompose the nicotinamide that can inhibit the activity of methane bacteria, which is conducive to biogas fermentation.

4.1.3 Cow dung as an ideal mixing material for biogas fermentation of discarded fresh tobacco leaf. After being ruminated, the cow dung is digested more fully, and mixing discarded fresh tobacco leaf with cow dung will cause slight acidification of biogas slurry, thus having a small effect on the activity of methane bacteria, which will help to quickly produce biogas. In addition, the cow dung itself is rich in methane bacteria, which will increase the number and types of methane bacteria in biogas slurry, more conducive to rapid generation of biogas. Chicken manure contains a lot of nitrogen, and it is acidic[6]. After being digested by chicken, there is still much energy, and it easily causes acidification after anaerobic fermentation. It does not contain methane bacteria, so there is a certain lag in biogas generation, but the biogas fermentation has long duration.

4.2 Discussions The biogas slurry and biogas residues generated from anaerobic fermentation of discarded fresh tobacco leaf via biogas digester contain many kinds of trace elements such as N, P and K, and are ideal tobacco fertilizers having the features of both quick-acting fertilizer and slow-acting fertilizer. In addition, after biogas fertilizer is applied to the soil, it can increase the fertility of soil for planting tobacco, improve physical and chemical properties of soil, increase microbes in soil, significantly improve tobacco seedling's ability to resist frost and pest, and effectively reduce the occurrence of early flowering and pests. According to current statistics and reports as well as relevant experiments, it is found that the biogas fermentation broth can eliminate nearly 30 kinds of diseases for various crops such as grain crops, cash crops and vegetables, and it can partially replace pesticides[7-8]. Therefore, the study of returning biogas slurry to farmland and the effect of biogas slurry on tobacco growth will become an important research subject for people in the future.

References

[1] HAN Q, ZHANG MY. Manufacture techniques of papermaking leaf[J]. Journal of Northwest University of Light Industry,2002,20(1):19-22. (in Chinese).

[2] PENG GX, LI P, WU XG, *et al*. Research progress on the comprehensive utilization of tobacco waste[J]. Journal of Anhui Agricultural Sciences, 2013, 41(9):4036-4038. (in Chinese).

[3] LI J, LI JC, WU XH, *et al*. Progress in research on comprehensive utilization of tobacco waste[J]. Yunnan Chemical Technology,2010,37(2):44-49. (in Chinese).

[4] ZHANG JG. Biogas technology and its application[M]. Beijing: Chemical Industry Press,2005. (in Chinese).

[5] WU XW, LIU RH. The research of the anaerobic fermentation of agriculture residue to produce biogas[J]. Chinese Agricultural Science Bulletin,2011, 27(26):227-231. (in Chinese).

[6] LI RF, LAN CL, MA B, *et al*. Research progress of crude material on methane ferment[J]. Chinese Agricultural Science Bulletin,2011,27(30): 1-5. (in Chinese).

[7] ZHANG XH. The application of biogas manure in crop diseases and pest prevention[J]. Rural Energy,1994(6):23-25. (in Chinese).

[8] CHEN LQ, YIN F, LIU SQ, *et al*. Study the inhibition effect of different sources of deposited biogas fluid on Alternaria alternata[J]. Chinese Academic BBS,2005(29):23-25. (in Chinese).

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References

[1] WANG L, WANG I, WANG M, *et al*. Contaminate characteristic of heavy metals in soils in Shenmu mining area[J]. Ecology and Environmental Sciences, 2011, 20(8-9): 1343-1347.

[2] GUO WJ, JIANG XW, CHEN XJ, *et al*. Research on soil remediation technology of heavy metal pollution abandoned land in metal mine[J]. Journal of Anhui Agricultural Science, 2010, 38(22): 11954-11956.

[3] LIAO GL, ZHOU YD, WU C. Forecast models of heavy metal contamination near tailing dam and their application[J]. Journal of Central South University Technology: Science and Technology, 2004, 35(6): 1009-1013.

[4] TESSIR A, CAMPBELL PGC. BISSON M. Sequential extraction procedure for the speciation of particulate trace metals[J]. Analytical Chemistry, 1979, 51(7): 844-851.

[5] XU Y, LUO F, XU RY, *et al*. Research on determination methods for pH value of agricultural soil in Sanya District[J]. Journal of Changjiang Vegetables, 2011(24): 50-51.

[6] MULLER G. Index of geoaccumulation in sediments of the Rhine River[J]. Geojournal, 1969(2):108 - 118.

[7] JI YQ, FENG YC, WU JH, *et al*. Using geoaccumulation index to study source profiles of soil dust in China[J]. Journal of Environmental Sciences, 2008, 20(5):571 - 578.

[8] LOSKA K, WIECHULA D, KORUS I. Metal contamination of farming soils affected by industry[J]. Environment International, 2004, 30(2): 159 - 165.

[9] WEI BG, YANG LS. A review of heavy metal contaminations in urban soils, urban road dusts and agricultural soils from China. Microchemical Journal, 2010(94):99 - 107.

[10] Safoura Javan, Amir Hessam Hassani, Ahmad Gholamalizadeh, *et al*. Fractionation of heavy metals in bottom sediments in Chahnimeh 1, Zabol, Iran[J]. Environmental Monitoring Assessment, 2015(187): 340-351.

[11] Perin G, Craboledda L, Lucchese M, *et al*. Heavy metal speciation in the sediments of Northern Adriatic sea. A new approach for environmental toxicity determination[C]. Heavy Metals in the Environment, 1985(2): 454-456.

[12] GAN GJ, LIU W, QIU YQ, *et al*. Heavy metal pollution and ecological risk assessment of the paddy soils in a smelting area in Central Hunan [J]. Environmental Chemistry, 2013, 23(1): 132-138.

[13] GUO WH, LIU XB, LIU ZG, *et al*. Pollution and potential ecological risk evaluation of heavy metals in the sediments around Dongjiang Harbor, Tianjin[J]. Procedia Environmental Science, 2010(2): 729-736.