Effect of nitrification inhibitor on Maturity and H_2S Emissions during Kitchen Waste Composting

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Abstract. In order to release the emissions of H_2S, this study designed experiments investigate the effects of nitrification ($NaNO_3$, $NaNO_2$ and ammonium molybdate) on producing and releasing H_2S during kitchen waste composting. All treatments were analyzed using 60L heat insulated composting vessels with forced aeration systems. Temperature, O_2, NH_3, GI were carried out as indexes. The result shows that compare with contrast, $NaNO_3$ and ammonium molybdate could release emissions of H_2S, while $NaNO_2$ would increase emissions of H_2S, and ammonium molybdate have the best effect on H_2S emissions during kitchen waste composting.

Introduction

During Kitchen waste composting there are many problems, such as emissions of H_2S. As a kind of low olfactory threshold gas, emissions of H_2S not only reduce the nutrient content of compost, but also cause serious pollution of stench [1]. How to increase nutrient content and reduce emissions of stink had aroused many attentions. Researchers did many studies in this filed. GUI Xianyang et al. added Hematite and magnesium oxide during Aquaculture waste anaerobic fermentation found that this two kinds of additive could inhibition of H_2S emissions[2] Bernardo et al. found that add Sodium nitrite and sodium molybdate in pig manure could control emissions of H_2S[3]. ZHANG Hong-yu added 4 kinds of nitrogen control materials(H_3PO^{4+}、$Mg(OH)_2$、$Ca(H_2PO_4)_2$ and $FeCl_3$)into kitchen waste to research the influence of NH_3 and H_2S emissions, and found that the four kinds of materials are controlled by different reduction mechanism to reduce emissions of NH_3 and H_2S [4].

Materials and methods

Raw materials and treatments design. The mixed household waste (with the size among 15-80 mm) used in this experiment was collected from Ma Jia-lou pre-sorting station in Beijing. In this study, four group experiments were conducted with nitrification inhibitor, the treatments design as below.

Table 1 Design of experiment

Item	T1	T2	T3	T4
nitrification inhibitor	------	$NaNO_2$	$NaNO_3$	$(NH_4)_6Mo_7O_{24}$

The composting cycle is 30 days. Take the forced ventilation which is 3.3m^3/ m^3·h (ventilate

shutoff 20 min and turn on 40 min). Turns heaps and sampling time are 0d, 3d, 7d, 14d, 21d and 30d, turn out all material and fully blending, take 500 g for solid indexes determination follow-up. Then put material back into the fermentation tanks continue composting experiment.

Analysis method. Composting temperature recorded by the temperature automatic monitoring system, directly read by computer. Germination index (GI) is used fresh samples extraction liquor in deionized water, solid-liquid ratio is 1:10, take 9 ml extraction liquor in a petri dish with a filter paper ,put 10 seeds in it then placed in a incubator with the temperature of (20±1) ˚C , cultivate 48 h. The moisture content was determined by drying the samples at 105˚C until the weight was constant.

Results and discussion

Changes of temperature. Temperature is an important index to reflect the catabolism of organic matters and microbial activity changes in compost material [5]. It is can be see in Fig.1, temperature of four treatments (T1,T2,T3 and T4) had a same tendency during composting, all risen at first (CK,TI,T3 were 1^{st} to 7^{th} ,T2 was 1^{st} to 13^{th}) and went down latter. Organic matters decompose and release a large mount heat due to the rise of temperature at initial phase. The later part of composting, decomposable organic matters used up, temperature decline and approach room temperature. Changes of T2 had a little different from other three treatments. It is because $NaNO_2$ have inhibitory effect on microorganism growth, so microorganism growth irregular. at first. Along with proceed of composting, $NaNO_2$ oxidation slowly in compost material changed into $NaNO_3$, did not have inhibitong effect on microorganism, so the tempreture rise up later. The thermophilic phase(>55˚C) of four treatments lasted 11 days, 10 days, 6 days and 11 days. All treatments met the Chinese standard of >55˚C for 5-7 days for sanitation [6].

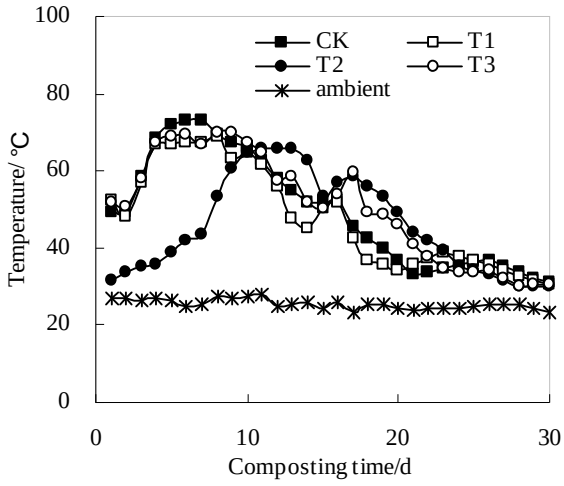


Fig.1 Changes of temperature of different treatments during composing

Changes of O_2. The O_2 concentrations affect the activity on microorganism in aerobic composting process, and furthermore reflect the symbol of decomposition degree of organic matter [7]. Changes of outlet O_2 concentration during composting were shown in Fig.2. Change of O_2 concentration of all four treatments are similarity, all have a brief drop at the beginning days of compost and then rise gradually. Falling of O_2 concentration during compost is due to consume of O_2 by microbial decompose organic matter. Turning compost material improve environment of compost body, accelerate decompose organic matter by microbial. At the beginning of compost, O_2 of T2 had a high concentration due to $NaNO_2$ is a kind of preservative, would inhibits the growth of microorganisms, so microorganisms growth retardation, could not fully decomposition organic matter to release enough heat.

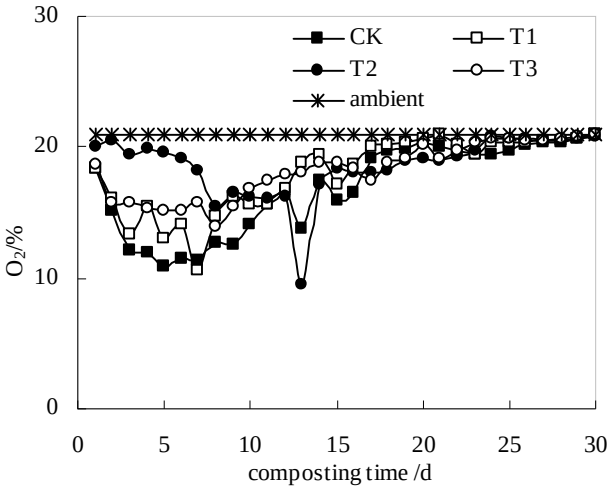
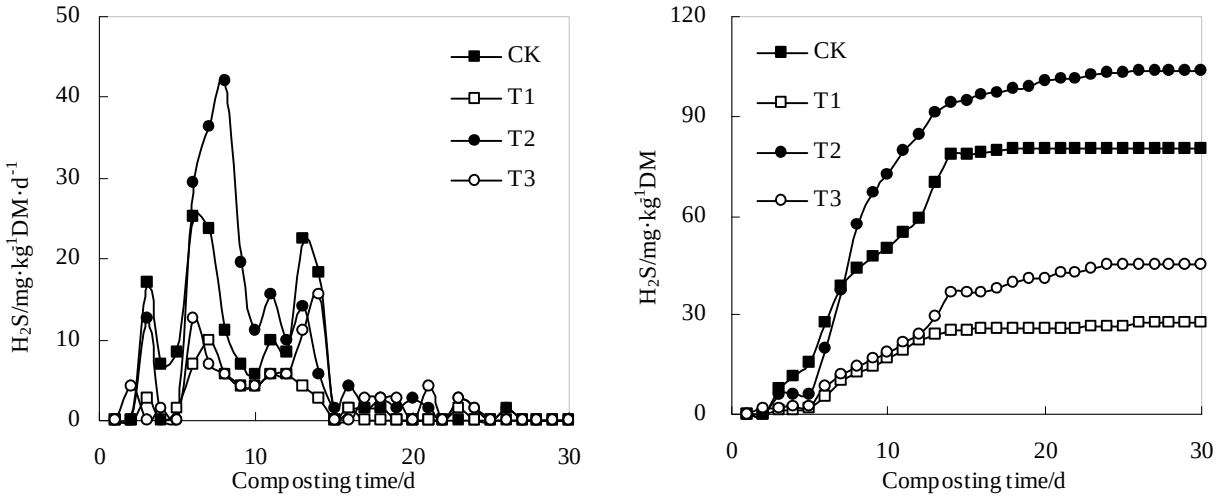


Fig.2 Changes of O_2 of different treatments during composing

Changes of H_2S emissions. H_2S is the by-product in the process of organic matter anaerobic fermentation [8]. Changes of H_2S concentration and cumulative of different treatments during composting are shown in Fig.3. O the whole, emissions of H_2S all low at the beginning of compost, emissions of H_2S most take place in first two weeks, some researchers found similar rules [8-10]. Compare with contrast, added of $NaNO_3$ and ammonium molybdate release emissions of H_2S, while as $NaNO_2$ increase emissions of H_2S. Though the Fig.3b, we can find that $NaNO_3$ have the best effect on emissions of H_2S, next is ammonium molybdate, and $NaNO_2$ will promote H_2S emissions. T2 has the lowest H_2S emissions is due to add $NaNO_3$ in compost material could add NO_3^-, the microorganism which use NO_3^- produce NH_3 and the microorganism which use SO_4^{2-} produce H_2S have competitive relation, when NO_3^- and SO_4^{2-} exsit at same time, microorganism will use NO_3^- first, there by inhibit emissions of H_2S. H_2S emissions of T3 lower than contrast deal to nitrate reductase containing Mo, added of ammonium molybdate increase the number of nitrate reductase and accelerate use of NO_3^-, and nitrate-reducing bacteria dominant in biochemical reactions, inhibit emissions of H_2S.



a. H_2S emissions during composting b. Cumulative emissions of H_2S during composting

Fig.3 Changes of H_2S concentration and cumulative of different treatments during composting

Changes of GI. Germinate seed experiment with composting extraction liquor is the most effective and accurate method to confirm toxicity and maturity of compost material [12]. It is often be used to evaluate performance of plants sprout and take root. Composting material is deemed

have been maturity when GI is larger than 50%, and have no toxicity to plants. Composting material is deemed have been maturity completely when GI is larger than 80%, and have no effect to plants sprout and take root[13]. Changes of GI during composting are shown in Fig.4. GI of four treatments all presented a rising tendency during composting. Along with proceed of composting, toxic substance was decomposed persistently, and composting material was approach maturity. At the end of composting, GI values of CK, T1, T2 and T3 were 62.1%, 54.1%, 65.9% and 71% respectively. All four treatments up to the standard of harmless only.

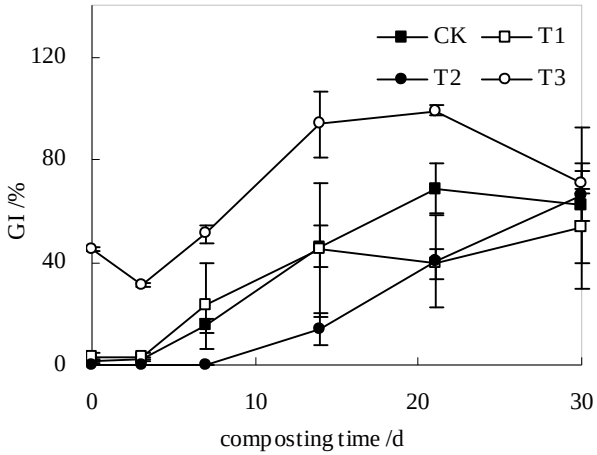


Fig.4 Changes of GI of different treatments during composing

Conclusion

(1) All four treatment met the Chinese standard of >55˚C for 5-7 days for sanitation (Chinese Standard DB11/T 272-2005).

(2) It can be seen from emissions of H_2S, we can find that $NaNO_3$ have the best effect on emissions of H_2S, next is ammonium molybdate, and $NaNO_2$ will promote H_2S emissions.

(3) It can be seen from GI, all four treatments up to the standard of harmless only.

(4) Under the condition of four experiments, $NaNO_3$ the best nitrification inhibitor for reduce emissions of H_2S comprehensive the views above.

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