Effect of nitrification inhibitor on Maturity and H$_2$S Emissions during Kitchen Waste Composting

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**Abstract.** In order to release the emissions of H$_2$S, this study designed experiments investigate the effects of nitrification (NaNO$_3$, NaNO$_2$ and ammonium molybdate) on producing and releasing H$_2$S 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$_2$S, while NaNO$_2$ would increase emissions of H$_2$S, and ammonium molybdate have the best effect on H$_2$S emissions during kitchen waste composting.

**Introduction**

During Kitchen waste composting there are many problems, such as emissions of H$_2$S. As a kind of low olfactory threshold gas, emissions of H$_2$S 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$_2$S emissions [2] Bernardo et al. found that add Sodium nitrite and sodium molybdate in pig manure could control emissions of H$_2$S [3]. ZHANG Hong-yu added 4 kinds of nitrogen control materials( H$_3$PO$_4$+, Mg(OH)$_2$, Ca(H$_2$PO$_4$)$_2$ and FeCl$_3$ ) into kitchen waste to research the influence of NH$_3$ and H$_2$S emissions, and found that the four kinds of materials are controlled by different reduction mechanism to reduce emissions of NH$_3$ and H$_2$S [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>
<thead>
<tr>
<th>Item</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>nitrification inhibitor</td>
<td>------</td>
<td>NaNO$_2$</td>
<td>NaNO$_3$</td>
<td>(NH$_4$)$_6$Mo$<em>7$O$</em>{24}$</td>
</tr>
</tbody>
</table>

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 an 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,T1,T3 were 1st to 7th, T2 was 1st to 13th) 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 NaNO₂ have inhibitory effect on microorganism growth, so microorganism growth irregular. at first. Along with proceed of composting, NaNO₂ oxidation slowly in compost material changed into NaNO₃, did not have inhibitong effect on microorganism, so the temperature 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 composting](image)

**Changes of O₂.** The O₂ 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 O₂ concentration during composting were shown in Fig.2. Change of O₂ concentration of all four treatments are similarity, all have a brief drop at the beginning days of compost and then rise gradually. Falling of O₂ concentration during compost is due to consume of O₂ by microbial decompose organic matter. Turning compost material improve environment of compost body, accelerate decompose organic matter by microbial. At the beginning of compost, O₂ of T2 had a high concentration due to NaNO₂ 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 composting

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. Overall, emissions of $H_2S$ are low at the beginning of composting, and emissions of $H_2S$ most take place in the 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 $SO_4^{2-}$ exist 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 $H_2S$.

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](image)

**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$_2$S, we can find that NaNO$_3$ have the best effect on emissions of H$_2$S, next is ammonium molybdate, and NaNO$_2$ will promote H$_2$S 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$_2$S comprehensive the views above.

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**References**


