Fertilizer Quality of Co-Composting of Typical Agricultural Wastes in China

GAO Hui, ZHOU Chuan-bin, WANG Ru-song*

Abstract

This study selected typical agricultural waste like swine waste, corn stalk and rice husk as composting material with three dry mass ratios of 1:1,1:1.5,1:2 respectively, the same biological agent was added to the composting mixture with blank contrast group. After 84 days static aerobic composting process, maturity indicators (temperature, carbon nitrogen ratio, seed germination index), organic nutrient indicators (organic matter content, total nitrogen ,total phosphorus and total potassium) and hygienic indicators (value of Faecal coliforms and rate of roundworm egg destroyed) were investigated about their evolution, comparison of composting quality was studied with the effect of biological agent on the co-composting of agricultural waste. Results showed that the treatment of corn stalk co-compost with swine waste as 1:1.5 ratio with addition of biological agent was the first to achieve maturity and had the higher level of organic fertilizer quality, treatments without addition agent had tiny difference. Meanwhile, the effect of biological agent on acceleration of degradation got verification, hygienic indicators of the compost product were satisfied with the relevant harmless standards. A good effect was proved by co-composting swine waste with corn stalk. However, rice husk compost didn't reach ideal high temperature. The maturity effect of compost product was relatively poor. Except the treatment of rice husk mix swine manure as 1:2 ratio with agent, other treatments had lower and less effective products ,positive effect had no seen in the rice husk compost. The aim of the study was to provide a reference basis for the application of microbial fermentation technology on agriculture wastes.

Key words: agriculture waste, co-compost, biological agent, organic fertilizer quality

1.Introduction

China is a big agricultural country, and has great crop straws resource. According to the relevant

* Corresponding author. E-mail：wangrs@ rcees.ac. cn, fax:0086-10-62943807,tel:（010）62943807
GAO hui
Research Center for Eco-Environmental Science，Chinese Academy of Sciences，Beijing 100085，China; College of Urban and Environmental Science, Xinyang Normal University, Xinyang 46400, Henan, China. E-mail：gaohui8010@gmail.com
ZHOU Chuan-bin
Research Center for Eco-Environmental Science，Chinese Academy of Sciences，Beijing 100085，China
WANG Ru-song
Research Center for Eco-Environmental Science，Chinese Academy of Sciences，Beijing 100085，China

data from 2012 Chinese Rural Statistical Year book ,yield of cornstalk and straw is about 66% of the total crop straw. If not being disposed properly, these wastes may cause secondary pollution to environment. Meanwhile, with the development of scale livestock farming, more and more wastes are produced , especially swine manure is the largest and contribute to 46.3% of the total livestock waste[2]. Pollution caused by Livestock and poultry wastes have been one of the main source of agricultural non-point pollution in China. It's an urgent issue to utilizes and recycle these organic resource, which bears great theoretical and practical significance to guarantee the urban and rural environment and promote the regional economic development.

From the perspective of utilization, crop straw and livestock manure containing rich nutrient elements, are useful organic matter resources. Anaerobic biogas fermentation and aerobic compost combine breeding waste treatment with planting waste treatment regarding crop straw as conditione[3]. Although anaerobic biogas fermentation conforms to the ecology principle, this technology has higher investment and operation cost, and influenced by low temperature effect in winter. Aerobic composting is an efficient way of agriculture waste disposal, which can reduce the pollutant amount, make the pollutant harmless and use it as a resource .Aerobic composting is a widely used technique for solid waste treatment; the equipment of composting develops rapidly[4-7].In resent years, some literatures focused on changes of biochemical indicators[5,8], maturity[4]and stability of compost products[6], effect of product cultivation[9]. Domestic and foreign scholars conducted a series of researches on the theory and practice about solving the long-time fermentation problem of conventional composting, such as biological agent was added to accelerate decomposition during composting process[10].

In China, compost application is an age-old practice for better yield and the potential of compost in soil fertility improvement has been demonstrated in china and elsewhere[11]. However, it may be mentioned here that agricultural wastes perform worse if compost alone, this is because livestock wastes like swine manure have low level of carbon to nitrogen ratio（C/N）that lead to reduction of fertilizer effect from nitrogen loss. yet, crop production wastes like corn stalk have high level of C/N ratio that decrease the decomposition rate of the organic material. It is necessary to co-compost these two types of agriculture wastes to regulate C/N ratio and slow down the maturation phase.

In view of small-scale decentralized composting pattern, it can effectively reduce the transportation cost, and achieve the target of treatment and utilization synchronously on the spot. In process of decentralized compost, little attention has been given to provide technical reference for the farmers on some problems, such as how to select material and rational matching them ,how to control and manage compost process, necessary or unnecessary addition of biological agent, how to measure the compost quality, eta. These issues need further scientific research. This study selected typical agricultural waste like swine waste, corn stalk and rice husk as composting material with three dry mass ratios, the same biological agent was added to the composting mixture with blank contrast group. After 84 days static aerobic composting process, maturity indicators (temperature, C/N ratio and seed germination index-GI), organic fertilizer quality indicators (organic matter content,TN ,TP and TK)and hygienic indicators (value of E.coli and rate of roundworm egg destroyed) were investigated about their evolution, comparison of composting quality was studied with the effect of biological agent on the co-composting of agricultural waste. The aim of the study was to provide a reference basis for the application of microbial fermentation technology on agriculture wastes.

2 Material and Method

2.1experimental materials

Chinese main agriculture waste swine manure, corn stalk and rice husk were chosen as raw material for co-composting. Swine waste were collected from a pig farm, corn stalk and rice husk were acquired from an ecological farm in suburban of Beijing, Corn stalk was crushed to 3 centimeters long. Experiments were conducted in plastic greenhouses, the compost vessel was a 40L bucket with cover and 3 centimeters sponge to wrap the outer for isolation . there were holes on the cover accounting for 30% area with 10mm diameter. Physical and chemical properties of raw material were displayed in table 1. Two types of condition agents (corn stalk and rice husk) co-compost with swine waste as dry mass ratio of 1:1,1:1.5and 1:2,. Complex biological agent was added to the mixture which contained fungi, actinomycetes, lactobacillus bacillus and so on. In every 1 kilogram of raw materials to add 5 grams of agent into the compost vessel mixing, there were 4.35E+7cfu.g-1 living bacteria count in each of the vessel, comparing to the control without microbial agent. Each treatment had 3 replicates. Raw material proportions for co- composting were showed in table2. Compost process went through from July 5th to September 27th in 2013， the time was 12 weeks.

Table 1. Physical and chemical properties of raw material for composting

material	Water content（%）	pH	Organic matter（%）	C/N	Total P（%）	Total N（%）
Swine waste	65.4（±0.67）	8.12（±0.09）	56.45（±1.05）	12.52（±1.24）	0.345（±0.05）	2.09（±0.01）
maize straw	7.8（±0.08）	6.62（±0.03）	95.6（±2.38）	49.9（±4.51）	0.15（±0.02）	1.07（±0.002）
rice husk	8.3（±0.07）	6.81（±0.04）	60.6（±1.14）	103（±8.24）	0.032（±0.0006）	0.48（±0.005）

Note: The sample for determination of water content and pH was wet basis, the sample for determination of organic matter, total N and total P was dry basis; values in the parentheses were standard deviations of all physiochemical analyses of the raw materials，n=3

Table 2　Raw material proportions for composting（wet weight，unit: gram）

treatment scheme	symbolic names	swine waste	corn stalk	rice husk	biological agent
corn stalk: swine waste=1:1	C1	2000	750.5	-----	13.75
corn stalk: swine waste=1:1(without addition)	C1#	2000	750.5	-----	-----
corn stalk: swine waste=1:1.5	C2	2000	500.3	-----	12.5
corn stalk: swine waste=1:1.5(without addition)	C2#	2000	500.3	-----	-----
corn stalk: swine waste=1:2	C3	2000	375.3	-----	11.9
corn stalk: swine waste=1:2(without addition)	C3#	2000	375.3	-----	-----
rice husk: swine waste=1:1	R1	2000	-----	750.5	13.75
rice husk: swine waste=1:1(without addition)	R1#	2000	-----	750.5	-----
rice husk: swine waste=1:1.5	R2	2000	-----	500.3	12.5
rice husk: swine waste=1:1.5(without addition)	R2#	2000	-----	500.3	-----
rice husk: swine waste=1:2	R3	2000	-----	375.3	11.9
rice husk: swine waste=1:2(without addition)	R3#	2000	-----	375.3	-----

2.2 experimental method

This study adopted turning piles to increase air-flow rate , every second day in the first week ,later once a week.In the middle of the pile body of 25 centimeters deep placed a thermometer, measure the temperature two times at 9:00 and 15:00 every day in the first week, then one time at 15:00 , measurement precision was improved by averaging the testing values of various point of the full size, monitoring environmental temperature change at the same time. During the composting process, water content sustained within the scope of 50~60%[12,13].Using four-classification sampling method to collect 50 grams sample on day 0, 3,7, 14,21, 28 ,35,42,49,56,63,70,77and 84 respectively, the sample was divided to two parts, one stored in a freezer at 4℃,the other allowed to air dry. Fresh samples stored in freezer was applied to determine the indicator including water content, GI, value of E.coli and rate of roundworm egg destroyed. Air-dry sample was ground and sifted for measuring some indicators including total nitrogen(TN), carbon nitrogen ratio(C/N ratio) , total phosphorus(TP) and organic matter content(OM content) .

The dry matter of the samples was determined after 12h at 105℃.OM was assessed by determining the loss-on ignition at 430℃ for 24h[14].The fresh samples were analyzed for GI in a 1:10(w/v)water-soluble extract, E.coli were by the multiple-tube fermentation technique, rate of roundworm egg destroyed were counted by the saline saturation solution floating concentrated techniques[15,16], NT and CT were determined by automatic microanalysis [17],TP and TK were determined by inductively coupled plasma-atomic emission spectrometry(ICP-AES) with a microwave digestion method[14].The seed germination index was determined with Lepidium sativum L.seed, using the method described by Zucconi et al. [18].Twenty seeds were seeded in triplicate in a peri dish containing filter paper wetted with 5 ml of 1:10 compost: ater extract from different composts. A petri dish containing a filler paper wetted with deionized water was kept as a control. After incubation at 25℃ for 48h,the seed germination percentage and root length of the germinated seeds were recorded. The germinated index(GI)was calculated using the following expression: GI(%)=(%seed germination ×% root growth)/100

2.3 Statistical analysis

Microsoft Excel 2010 and Spss18.0 was used for statistical analysis. one-way ANOVA analysis was used to provide effect of treatment schemes on various parameters, and Duncan multiple testing method for comparison between treatment schemes . significant difference test was adopted at P=0.05.

3.result and discussion

3.1 maturity indicators

Maturity is of the main factor to measure the compost product quality, it ensure the secure use as well. Based on the exiting research results[3-5], this study chose temperature, C/N ratio and GI as maturity indicator.

(1)temperature

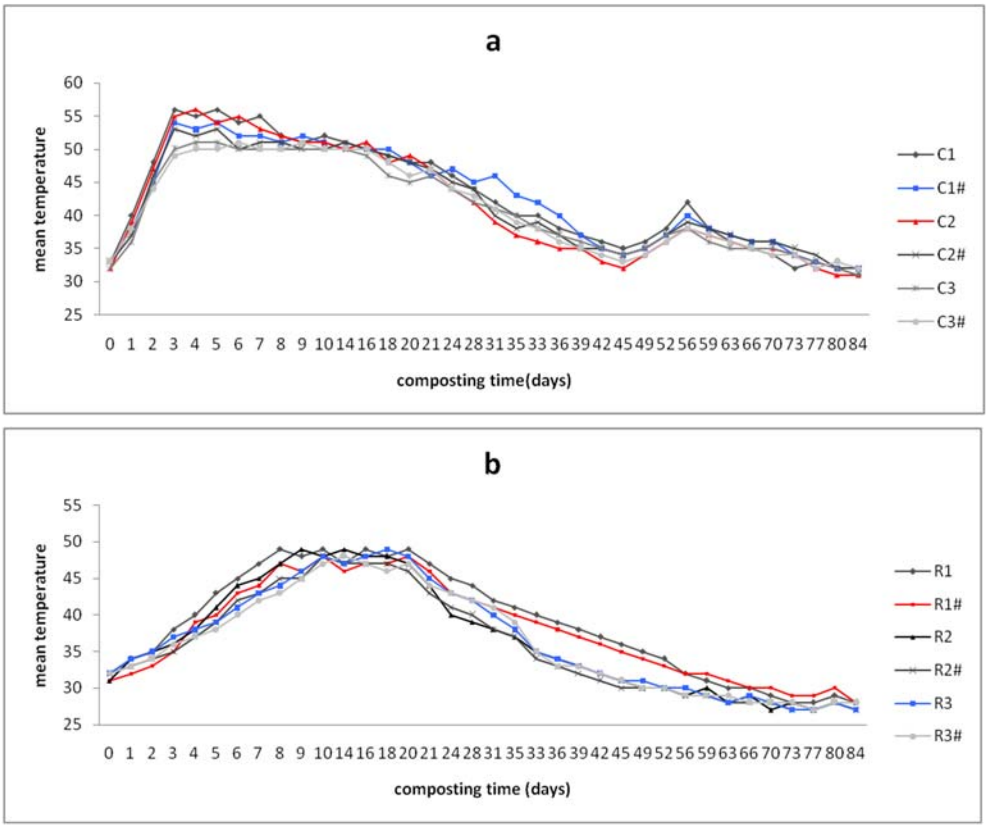

Fig.1 Temperature changes during the composting(a:corn stalk b: rice husk)

To the composting system, temperature was the reaction of the microbial action, it was the important factors influencing the microbial action and composting process, for composting process, temperature was the apparent manifestation of its state。At the beginning of the composting process, composting body contained easily decomposed organic matter that decomposed rapidly with the effect of aerobic microorganisms, these actions emitted a great deal of heat which caused the temperature rise. Figure1 showed three stages of composting temperature: rapid heating stage(0~7day), pyrolysis stage (8~16 day) and cooling maturation stage (after the 17day).it is observed from figure 1a that C1 treatment reached the above 50℃ at the third day because of the richer organic matter, then sustained for 14 days, Other treatment scheme reached above 50℃ successively and maintained the high temperature for 14 or 16days. With the reduction of volatile solid along the composting process, the temperature of composting body decreased, treatment schemes of microorganism inoculants had fast heating and cooling. The temperature of corn stalk treatment schemes satisfied Chinese hygienic standards for non-hazardous disposal of excreta （GB7959-2012）[16]。Figure1b showed rice husk treatment scheme didn’t reach 50℃ under the poor microorganism fermentation. There were some reasons leading to this situation, the first reason was rice husk contained a high content of lignin and lower water-soluble carbon , which couldn't be well utilized as energy by aerobic, the other was rice husk's worse hygroscopicity caused ventilator inadequacy in internal body, which affected the growth of aerobic microorganisms.

（2）C/N ratio

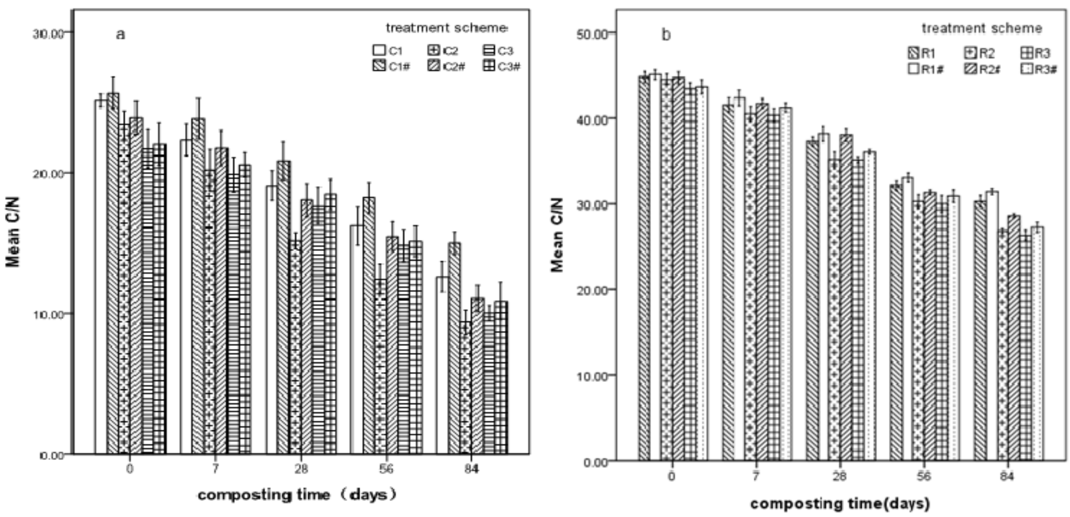

Fig.2 C/N ratio changes during the composting（mean±SD，a:corn stalk b: rice husk）

Figure 2 showed C/N ratio has a downside during compost process, the reason was during the process carbon source was consumed converting to carbon dioxide and humus, While nitrogen source was partially released in the form of nitrogen, partially transformed into nitrites and nitrates via nitrification， others were absorbed by organism. From figure 2a, At the end of the composting process, C/N ratio of corn stalk treatment schemes were below 20,while rice husk were above 25. Solid carbon nitrogen ratio currently was considered as one of the traditional indicators to measure compost maturity. Some researches took C/N ratio below 20 as maturity standard[19].But due to large difference of composting material, this conclusion was only regarded as a necessary requirement for maturity. Morel,et al[20] suggested adopt T value which equal to the final C/N ratio divided by initial ratio to evaluate maturity degree, furthermore when T value was less than 0.6. There were also researches considering T value within the scope of 0.53~0.72 or 0.49~0.59[21]. T value of C2 treatment was below 0.6 at the 56th composting day, which might be thought maturity. The same situation happened toC1, C2#、C3、C3# treatment at the70th composting day, T value of C1# treatment was below 0.6 at the end of the composting. T value of rice husk treatment were all above 0.65, maturity degree were not good.

By significance test, during the composting phase, corn stalk treatment with addition biological agent had significant difference（p=0.034）, ranging from small to large was C2、C3 和 C1.Among the treatments without addition.C1# treatment was significantly larger than C2# and C3#（p=0.029）,There were significant difference between the two treatments of same proportion with laws C1<C1#（p=0.025）、C2<C2#（p=0.036）、C3<C3#（p=0.043）,there were no significant difference among all the treatments of rice husk（p=0.257）.this result explained the effect of biological agents on the co-composting of corn stalk and 1:1.5 ratio was favored over other treatments, the same effect of biological agent didn't happen in all the rice husk treatments.

(3)Seed germination index(GI)

Table 3 The significance test of seed germination index in different treatment schemes (mean±SD)

treatment scheme	7days	28days	56days	84days
C1	25.1±3.2(c)	34.6±4.3(bc)	42.7±5.9(bc)	73.7±9.3(ab)
C1#	21.4±2.4(c)	25.6±2.6(c)	38.5±5.1(d)	65.6±7.1(c)
C2	37.8±5.2(a)	45.7±6.3(a)	59.4±7.6(a)	76.1±8.5(a)
C2#	29.8±4.1(bc)	33.4±4.2(bc)	40.8±5.4(cd)	73.2±8.1(bc)
C3	33.5±4.6(ab)	39.5±4.5(ab)	47.5±6.3(b)	74.8±8.7(ab)
C3#	30.3±3.4(ab)	35.3±3.9(ab)	43.1±4.3(bc)	70±7.4(b)
R1	13.5±1.5(ab)	23.6±2.4(ab)	32.7±3.4(ab)	36.9±4.1(bc)
R1#	10.1±1.1(ab)	18.9±2.0(b)	26.3±2.8(b)	32.1±3.4(c)
R2	16.3±1.7(ab)	25.7±2.7(ab)	34.6±3.2(ab)	40.3±4.5(b)
R2#	15.2±1.9(ab)	23.4±2.5(ab)	31.5±2.9(ab)	39.6±4.2(bc)
R3	23.5±2.1(a)	32.8±3.4(a)	41.7±3.7(a)	50.4±8.3(a)
R3#	18.7±1.9(ab)	29.5±3.1(ab)	38.4±3.5(ab)	42.4±4.6(ab)

Note: The same letters indicated insignificant difference among the treatment schemes in the same column, different letters meant significant difference（P<0.05）

Immature compost product restrained the growth of plant[22], Zucconi,et al.[18]and Rittaldi et al [23]considered compost product maturity when GI value reached 50% ,and plants were able to patient the product's toxicity. When GI value was more than of 80%~ 85% ,the compost product was thought completely non-toxic to plant. Table 3 indicated all the treatments had marked increase during composting process. experimental results showed GI value of C2 treatment began to be greater than 50% at the 56th day which meant maturity, this conclusion was consistent with the evaluation result of T value from carbon nitrogen ratio, other treatments of corn stalk reached maturity at the end of the compost judging from the GI value. And by significant test, as to treatment of addition agent, C2 treatment was significantly larger than C1and C3 treatment. C1#

treatment was significantly smaller than C2#and C3# for treatment without addition, between the treatment of same proportions, C2 and C2# treatment had significant difference. In terms of rice husk, only R3 treatment achieved the maturity requirement that was above 50%.Significant test showed significant difference exited between R3 and R1 treatment, the same to R3# and R1# treatments, other treatments had no significant difference during composting phase, these results reflected 1:2 proportion treatment (with and without addition biological agent)was favored over1:1 treatments on degradation.

（4）maturity degree comparison

By integrating and referring to the ideas of domestic and overseas scholars[24,25]. This study built index system including days for maintaining temperature more than 50℃,GI value, degradation rate of C/N which meant dividing the minus of initial and final C/N by final C/N (table 4), compost product compared and contrasted with classification figure in Table 4, maturity level was reached qualitatively. Some conclusion were drawn by contrast ,the level of corn stalk was higher than rice husk, C2 treatment was the most optimal schemes(Best –maturity), C1# was relatively worse(Basic-maturity)。In terms of rice husk, R1 and R1# treatment was immaturity ,others were basic-maturity level. These results illustrated organic matter got stability with the action of mineralization and humification, compost product of rice husk were in lower maturity.

Table 4 Classification of compost maturity level

	Best -maturity	Better- maturity	Basic-maturity	Immaturity
days for maintaining above 50℃/d	16	13	10	7
degradation rate of C/N/%	60	50	30	12
GI%	80	60	50	30

3.2 organic nutrient indicators

nutritional value of compost products directly impact their organic fertilizer quality, some parameters like OM content, TN, TP and TK were often used as characterization for nutritional value.

(1)OM content

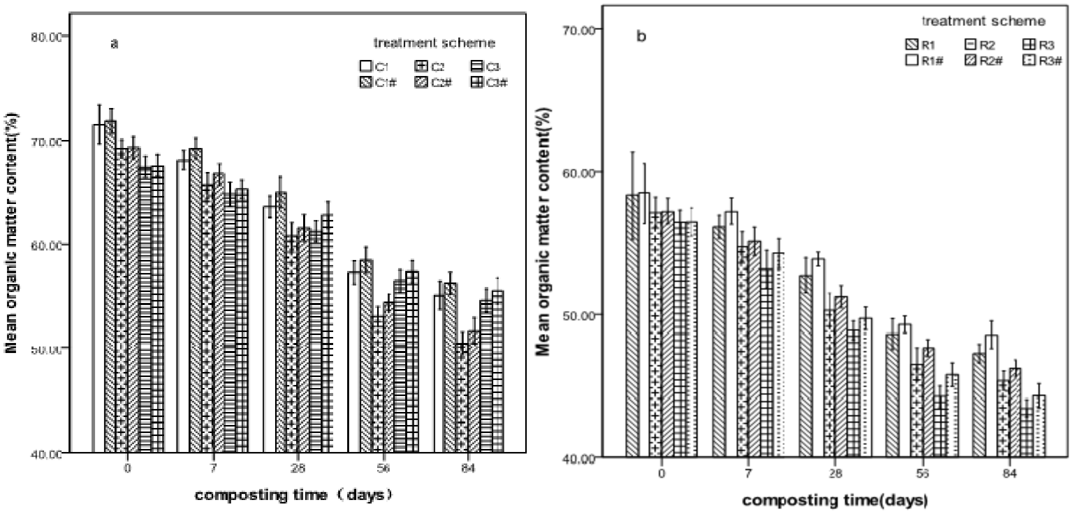

Fig3 organic matter content changes during the composting（mean±SD，a:corn stalk b: rice husk）

Figure 3 showed OM content was in range 40.0%~75.0%，which belonged to suitable scope 20.0%~80.0% suggested by Lopez Zavala M A,et al[26]. Figure 3 demonstrated the OM content took on the declining-ascending trend in both corn stalk and rice husk, then began to flatten after the 56th day. This indicated microbes absorbed carbon source containing in the soluble organic matter and decomposed OM with emitting carbon dioxide .Variable amplitude of OM content of corn stalk was 12％～20％, OM content decrease of treatment schemes in order was C2（decreased 18.71%），c2#（17.56%），C1（16.41%）,C1#(15.59%),C3(12.81%)and C3#（11.99%）. Variable amplitude of OM content of rice husk was 10%~13%, R3 treatment had the relatively high decrease. By significant test, as to treatment of addition agent, C2 treatment was lighter than C1and C3 treatment（p=0.026）,treatment without addition had no difference(p=0.067), between the treatment of same proportions, treatment with addition agent was lighter than treatment without addition. In terms of rice husk, due to less content of biodegradable organic carbon in rice husk ,swine manure had higher content respectively, OM content reduction came from degradation of swine manure, so there were no difference among rice husk treatments(p=0.103).Compost product of corn stalk and rice husk satisfied the Chinese standard of commercial organic fertilizer (NY525-2011) [27]about OM content 45%.

(2)TN

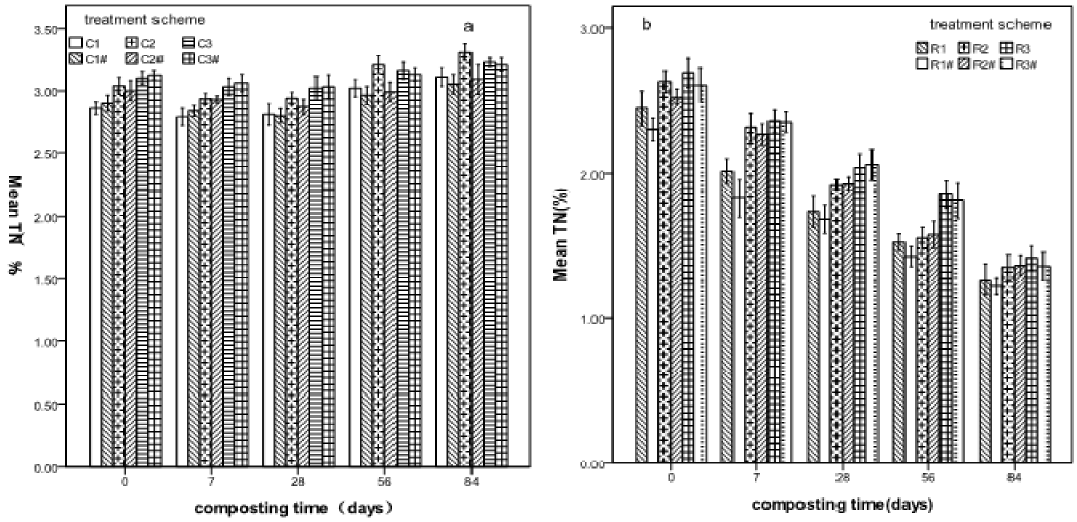

Fig.7 TN changes during the composting（mean±SD，a:corn stalk b: rice husk）

Figure7a showed TN rose during the composting process, concentration effect presented significantly[28]. This because the decrease of dry mass resulted by mineralization of organic matter, releasing loss of carbon dioxide and evaporation of water. But opposite trend appeared in figure 7b , nitrogen loss seriously. This phenomenon was caused by the reason that rice husk contained less biodegradable dissolved organic carbon, carbon loss as gas was limited, the decrease of the dry mass was not obvious, but nitrogen was in constantly volatilization losses with the rise of pH. Increase of TN is an important performance for compost produce to reflect maturity and quality, TN content decrease in rice husk compost process that indicated the unfavorable position of nitrogen maintenance.Through significance test，corn stalk treatments with addition agent in proper order were C2>C3>C1，the result explained the higher nitrogen degradation rate than loss rate .There were no difference in treatments without addition agent（$p=0.127$），between the treatment of same proportions, treatment with addition agent was lighter than treatment without addition. Difference in rice husk treatments were not obvious（$p=0.078$）.

(3)TP and TK

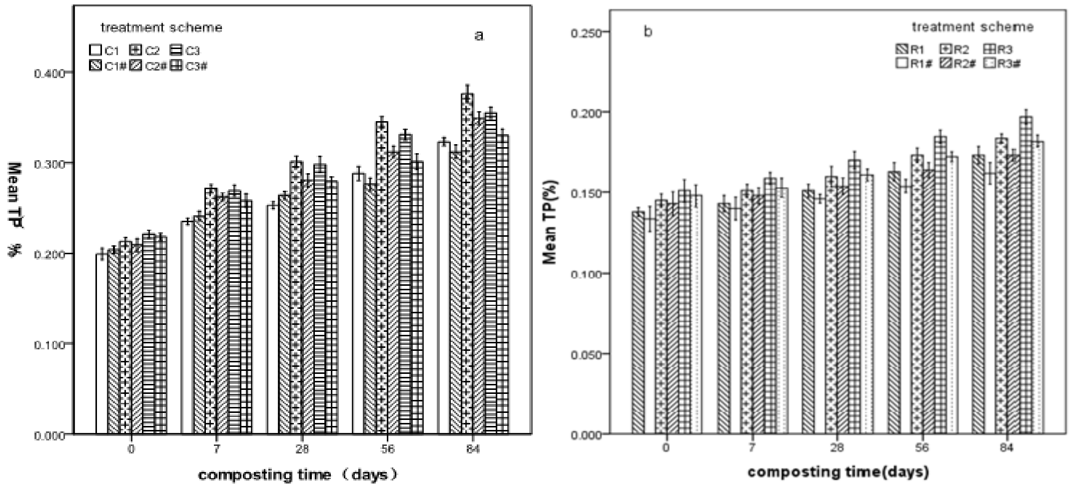

Fig.5 TP changes during the composting（mean±SD，a:corn stalk b: rice husk）

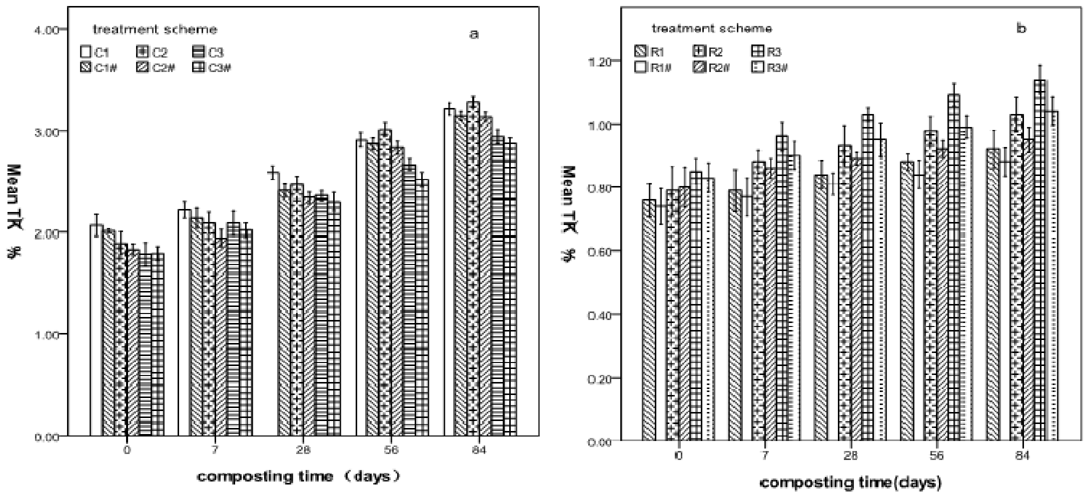

Fig.6 TK changes during the composting（mean±SD，a:corn stalk b: rice husk）

Absolute content of phosphorus in composting remained unchanged, but with the effect of microbial fermentation, degradation and transformation of dissolved organic matter and emissions of ammonia led to the decline of dry mass weight, the relative content of TP increased indirectly. Figure 5 showed the rise trend of TP in both corn stalk and rice husk treatment, TP content of corn stalk rose about 15%,rice husk treatments had no significant change(up just 5%)because of the limit reduction of dry mass weight. By significance test ,TP of C2 treatment was significantly larger than C1 and C3 treatment（p=0.041）,treatments without addition agent had no difference(p=0.067), between the treatment of same proportions, treatment with addition agent was higher than treatment without addition. Difference in rice husk treatments were not obvious （p=0.351）.This result was consistent with the OM content test, according to statistic result, there was negative correlation between TP and OM content in corn stalk treatment and rice husk treatment（corn stalk :r=0.-938，p<0.01;rice husk: r=-0.847，p<0.001），this demonstrated the greater degradation of OM, the higher contents of TP.

TK and TP promoted each other，TK changed in relatively small extent，the possible reason was potassium moved more easily than phosphorus, uneven distribution of potassium happened in pile with water flow. Significant test and statistic result of TK were consistent with TP.

（3）Organic fertilizer quality comparison

Based on the grade standard of organic fertilizer quality in China, this study evaluated the organic fertilizer quality of compost product[29]. By the evaluation results in Table 6, organic fertilizer quality of all the corn stalk treatment up to 2 level, R1、R1# and R2# treatment of rice husk were as worse as 4 level.

Table 5 grade standard of organic fertilizer quality and score grade standard

Rank	OM		TN		TP		TK		Total
	content/%	score	content/%	score	content/%	score	content/%	score	scores
1 level	>80	25	>3.0	40	>1.0	15	>4.0	20	86~100
2 level	50~80	20	1.5~3.0	32	0.5~1.0	12	2.0~4.0	16	71~85
3 level	30~50	15	0.5~1.5	24	0.3~0.5	9	1.0~2.0	12	56~70
4 level	15~30	10	0.3~0.5	16	0.1~0.3	6	0.6~1.0	8	41~55
5level	≤15	5	≤0.3	8	≤0.1	3	≤0.6	4	21~40

Table 6 organic fertilizer quality grading of treatment schemes

	C1	C1#	C2	C2#	C3	C3#	R1	R1#	R2	R2#	R3	R3#
rank	2	2	2	2	2	2	4	4	3	4	3	3

3.3. hygienic indicators

According to Chinese requirement of hygienic standards for non-hazardous disposal of excreta （GB7959-2012）[16], maximum composting temperature must reach 50℃ at least and hold for more than 10 days, value of E.coli was within the scope of 0.01~0.1, rate of roundworm egg destroyed achieved in range of 95~100%.Rice husk co-composting with swine waste didn’t reach the set temperature, so hygienic indicators of them weren’t in determination.Table8 showed hygienic indicators of corn stalk treatment schemes could satisfy the national standard..

Table7 the number of E.coli and roundworm egg during the co-composting of corn stalk with swine waste

treatment scheme	value of E.coli					rate of roundworm egg destroyed(%)
	0 day	3 days	7 days	14 days	84 days	
C1	0.000001	0.0056	0.105	0.6	1.1	100.00
C1#	0.000001	0.0046	0.053	0.4	1.0	100.00
C2	0.000001	0.0036	0.046	1.1	3.6	100.00
C2#	0.000001	0.001	0.043	0.6	3.6	100.00
C3	0.000001	0.0006	0.036	0.1	0.6	100.00
C3#	0.000001	0.0001	0.01	0.1	0.4	100.00

4.conclusion

This study showed that after 84d composting process, from maturity properties perspective ,corn stalk C2 treatment had fastest temperature rise, C/N ratio and GI reached mature level early in 56 days， C1# treatment had the worst mature among corn stalk treatments. To rice husk , all the treatments didn’t reach ideal high temperature. only R3 treatment got barely maturity, others were in immature status. From organic nutrient standpoint, organic nutrient level of corn stalk treatments got the secondary degree, rice husk R1、R1# and R2# treatment had error level(level 4),TN content decreased trough the compost process that indicated the unfavorable position of nitrogen maintenance. In terms of hygienic indicators, compost products of corn stalk were satisfied with the relevant harmless standards. Study also proved that biological agent played roles in corn stalk composting, but positive effect had no seen in the rice husk composting. Thus some conclusion could be drawn that corn stalk was favored over rice husk using as attendant agents in co-composting with swine manure and the suitable ratio of corn stalk to swine manure was 1:1.5 with addition biological agent.

From composting time point of view, some literature demonstrated it inefficient to mix rice husk with livestock manure directly[30,31]. This because rice husk contained a high content silica and lower water-soluble carbon , it was hard for microbes to absorb and utilize cellulose and lignin components. Zhang J H et al [32]and Soda et al [33]found rice husk ash had obvious effect on co-composting with livestock manure and remediation of acidic polluted soil, providing a new way for rice husk utilization as a resource in China.

The corn stalk in china is in large quantities and they posses excellent effect on co-composting in this study, which reduce the composting cost and produce better organic fertilizer. So corn stalk can be selected as a promising candidate for co-composting. According to the characteristics of high content of cellulose, hemicellulose and lignin in livestock manure and crop straw, efficient cellulose - decomposing microorganisms are suggested to separated and purified. measures are taken to reduce productive and sale cost of biological agent and attract more farmers to compost agriculture wastes on-site,organic deficiency in arable land may be improved.

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