

Effects of Chaff as Bulking Materials on Aerobic Composting of Food Wastes

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Abstract

This study was performed to examine the effects of chaff as bulking materials on temperature, pH, weight and volume reduction and salinity in aerobic composting of food wastes. Volume ratios of food wastes to chaff in reactor Control, Ch-1, Ch-2, Ch-3 and Ch-4 were 4:0, 4:1, 4:2, 4:3 and 4:4, respectively. Reactors were operated for 24 days with 1 hour stirring by 1 rpm and 2 hours aeration per day. The lowering of the volume ratio of food wastes to chaff resulted in the ascending of the highest reaction temperature and the elongation of the high temperature reaction period. The lowering of the volume ratio of food wastes to chaff resulted in the more fast time of pH ascending. The lowering of the volume ratio of food wastes to chaff resulted in the more fast consistency in the weight and volume reduction rates. Salinities were condensed by reaction days. The final salinity of Control was 2.79%, and the final range of salinities of chaff mixtures was 2.18 - 2.37%.

Keywords : Food wastes, Aerobic composting, Chaff, Bulking material, Temperature

I. introduction

The portion of food wastes in domestic solid wastes of Korea in 2000 was 25%. Food wastes of Korea contain the moisture contents of 80-85%. It causes many problems of odors, leachate and costs of transportation and treatment, etc. In this study, the effects of chaff as bulking materials on aerobic composting of food wastes were examined.

II. Materials and Methods

The composting reactors with the effective volume of 40L were attached by blower, stirrer and control box. Volume ratios of food wastes to chaff in reactor Control, Ch-1, Ch-2, Ch-3 and Ch-4 were 4:0(5L:0L), 4:1(5L:1.25L), 4:2(5L:2.5L), 4:3(5L:3.75L) and 4:4(5L:5L), respectively. Reactors were operated for 24 days with 1 hour stirring by 1 rpm and 2 hours aeration per day. The changes of temperature, pH, weight and volume reduction and salinity by reaction days were measured by Standard Methods (APHA, AWWA and WEF) and Korean certified test methods of solid wastes.

III. Results and Discussion

Table 1. Physico-chemical properties of food wastes and chaff

Items	Units	Food wastes	Chaff
PH	-	3.95	7.19
Density	Kg/L	0.80	0.12
Porosity	%	40.0	81.0
Moisture content	%	71.7	8.4
Total solid	%	28.3	91.6
Ash content	%	10.3	10.8
TOC	%	47.5	47.2
TKN	%	2.04	1.87
C/N ratio	-	23.3	25.2
Salinity	%	1.63	0.40
Conductivity	mS/m	42.8	5.7

The pH 3.95 of food wastes which contained organic acids by fermentation in Korean food culture was lower than the pH 7.19 of chaff . The porosity of 81.0% in chaff was higher than that of 40.0% in food wastes, therefore the role of chaff as bulking material was expected. Because of Korean food culture, the salinity in food wastes was very high.

As a result of comparison of temperature changes by reaction days, the lowering of the volume ratio of food wastes to chaff resulted in the ascending of the highest reaction temperature and the elongation of the high temperature reaction period. In consequence of comparison of pH changes by reaction days, the lowering of the volume ratio of food wastes to chaff resulted in the more fast time of pH ascending. These means that the appropriate volume ratios of food wastes to chaff for effective composting were 4:3~4:4.

Table 2. Comparison of weight changes by reaction days

(Unit : kg)

Reaction days	Control	Chaff			
		Ch-1	Ch-2	Ch-3	Ch-4
0	4.00(0.0*)	4.09(0.0)	4.21(0.0)	4.39(0.0)	4.57(0.0)
4	3.36(16.0)	3.44(15.9)	3.37(20.0)	3.51(20.1)	3.75(17.9)
8	2.68(33.0)	2.83(30.8)	2.40(42.0)	2.40(45.3)	2.72(40.5)
12	2.46(38.5)	2.37(42.1)	1.66(60.6)	1.99(54.7)	2.34(48.8)
16	2.37(40.8)	1.80(56.0)	1.51(64.1)	1.87(57.4)	2.27(50.3)
20	2.14(46.5)	1.54(62.3)	1.46(65.3)	1.69(61.5)	2.14(53.2)
24	2.08(48.0)	1.43(65.4)	1.41(66.5)	1.64(62.6)	2.06(54.9)

* ; weight reduction rate(%)

Table 3. Comparison of volume changes by reaction days (Unit : L)

Reaction days	Control	Chaff			
		Ch-1	Ch-2	Ch-3	Ch-4
0	5.0(0.0*)	5.5(0.0)	6.6(0.0)	8.5(0.0)	11.0(0.0)
4	4.0(20.0)	5.0(9.1)	5.5(8.3)	7.5(11.8)	9.5(13.6)
8	3.5(30.0)	4.5(18.2)	4.5(25.0)	6.2(27.1)	8.3(24.6)
12	3.3(34.0)	4.3(21.8)	4.0(33.3)	6.0(29.4)	8.2(25.5)
16	3.0(40.0)	4.0(27.3)	3.8(36.7)	5.9(30.6)	8.1(26.4)
20	2.8(44.0)	3.5(36.4)	3.5(41.7)	5.8(31.8)	7.9(28.2)
24	2.6(48.0)	3.0(45.5)	3.5(41.7)	5.8(31.8)	7.9(28.2)

* ; volume reduction rate(%)

The lowering of the volume ratio of food wastes to chaff resulted in the more fast consistency in the weight and volume reduction rates. This means that the volume ratio of food wastes to chaff of 4:3 - 4:4 resulted in the more fast completion of aerobic composting of food wastes.

Table 4. Comparison of salinity changes by reaction days (Unit : %)

Reaction days	Control	Chaff			
		Ch-1	Ch-2	Ch-3	Ch-4
0	1.63(0.0*)	1.36(0.0)	1.30(0.0)	1.27(0.0)	1.25(0.0)
4	1.78(9.2)	1.47(8.1)	1.42(9.2)	1.36(7.1)	1.32(5.6)
8	1.92(17.8)	1.74(27.9)	1.68(29.2)	1.60(26.0)	1.56(24.8)
12	2.24(37.4)	2.03(49.3)	1.96(50.8)	1.84(44.9)	1.78(42.4)
16	2.51(54.0)	2.31(69.9)	2.27(74.6)	2.21(74.0)	2.13(70.4)
20	2.63(61.4)	2.36(73.5)	2.29(76.2)	2.24(76.4)	2.15(72.0)
24	2.79(71.2)	2.37(74.3)	2.31(77.7)	2.26(78.0)	2.18(74.4)

* ; salinity increasing rate(%)

Salinities were condensed by reaction days. The final salinity of Control was 2.79%, and the final range of salinities of chaff mixtures was 2.18 - 2.37%. If the final products of composting would be used as composts or soil conditioners, they should be pretreated as the method of the mixing of another materials. They would be directly used as cover materials at the land fill sites.

IV. Conclusions

This study was performed to examine the effects of chaff as bulking materials on temperature, pH, weight and volume reduction and salinity in aerobic composting of food

wastes. Volume ratios of food wastes to chaff in reactor Control, Ch-1, Ch-2, Ch-3 and Ch-4 were 4:0, 4:1, 4:2, 4:3 and 4:4, respectively. Reactors were operated for 24 days with 1 hour stirring by 1 rpm and 2 hours aeration per day. The results are as follows.

- 1) The lowering of the volume ratio of food wastes to chaff resulted in the ascending of the highest reaction temperature and the elongation of the high temperature reaction period. the lowering of the volume ratio of food wastes to chaff resulted in the more fast time of pH ascending. These means that the appropriate volume ratios of food wastes to chaff for effective composting were 4:3 - 4:4.
- 2) The lowering of the volume ratio of food wastes to chaff resulted in the more fast consistency in the weight and volume reduction rates. This means that the volume ratio of food wastes to chaff of 4:3 - 4:4 resulted in the more fast completion of aerobic composting of food wastes.
- 3) Salinities were condensed by reaction days. The final salinity of Control was 2.79%, and the final range of salinities of chaff mixtures was 2.18 - 2.37%. If the final products of composting would be used as composts or soil conditioners, they should be pretreated as the method of the mixing of another materials. They would be directly used as cover materials at the land fill sites.

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