Manufacturing Methods of Multi-ingredient Compost with EM

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***Abstract** : This project is performed for increasing the integrated effect of EM by reasonable mixing of EM solution and multi-ingredient compost in agriculture. This compost has been manufactured by treating organic materials with EM and culturing other beneficial bacteria with high density, and by adding some minerals. The organic substrates were fermented by EM. There was a definite difference between organic substrates with and without microbial treatment. This is one of bio-active compound fertilizer.*

Introduction

The rational use of the high quality organic compost and efficient biological fertilizer in agriculture is one of the main ways for greater and safe yield with lower agrochemicals (Reganold and Parr, 1990; Litterick 1999). Moreover, the application of EM Bokashi prepared by fermenting organic materials such as rice bran, oil cake and fish meal containing various nutrients like N, P and S with EM, makes it possible to improve both quantity and quality of crops with a small amount of chemical fertilizer (Higa 1993). However, it is a good way for greater and safe yield to add the lacked nutrients and to use beneficial microbes capable to mobilize insoluble P, K and Microelements in soil under the circumstances of our country where these high quality organic resources are limited.

In this study, on the basis of the determination of the suitable conditions for manufacturing the multi-ingredient compost containing peat, humus soil and so on treated with EM, the effects of co-treatments of microbial inoculants and other ingredients were elucidated, and their physico-chemical properties were analysed.

Materials and Methods

The microbial inoculants used in this study are EM-1 (lactic acid bacteria and yeast) and EM-3 (photosynthetic bacteria ; PSB), nitrogen fixing bacteria (Azotobacter sp, Azospirillum spp.), and phosphorous and potassium decomposing bacteria (Pseudomonas spp., Bacillus spp.). The organic materials such as peat, humus soil, activated sludge, and the natural minerals as zeolite, apatite, vermiculite were used as substrates, and maize molasses as a carbonic source for microbial culture. The density of most of above mentioned microbes are in the range of $1x10^6$ to $1x10^9$ per ml.

Results and Discussion

1. Determination of Suitable Conditions for making Compost

a. Suitable conditions for solid fermentation

The pH of cultures at beginning of the fermentation affects greatly the growth of microbes (Figure 1). The growth of microbes was also affected by the water content of cultures (Table 1).

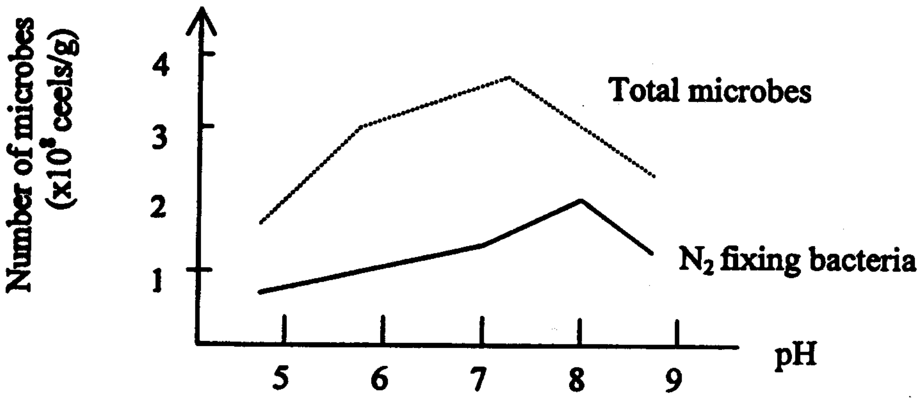

Figure 1. Effect of pH on Solid Culture of Microbes

Table 1. Effect of Water Content on the Growth of Microbes

Water Content (WHC %)	Microbial Populations (x 10^9 cells/g)		
	Total Microbes	NFB	Ratio of NFB Total Bact.
60	22.8	2.4	0.1
70	24.0	4.8	0.2
80	24.0	7.2	0.3
90	21.2	6.4	0.3

(NFB; nitrogen fixing bacteria, incubation time 72h, fermented substrates)

Table 2.Effect of Incubation Temperature on Microbial Growth

Water Content ˚C	Microbial Populations (x 10^9 cells/g)		
	Total Microbes	NFB	Ratio of NFB/ Total Bact.
20	8.4	8.0	0.95
30	13.2	8.0	0.60

(NFB; nitrogen fixing bacteria, incubation time 72h, fermented substrates)

As shown in Table 2, although there was no change in NFB, the total number of bacteria tend to increase with the incubation temperature from 20^{o}C to 30^{o}C , consequently, its ratio was reduced with the increase of temperature.

As the air condition affects the growth of microbes, the total amount of cultures for fermentation in container was also tested (Table 3).

Table 3.Effect of Total Amount of Cultures in Container on Microbial Growth

Amount of Cultures (W/V %)	Microbial Populations (x 10^9 cells/g)		
	Total Microbes	NFB	Ratio of NFB/ Total Bact.
10	14.4	0.8	0.05
20	20.8	3.2	0.15
30	42.4	5.6	0.13

(Incubation time 72h, 500ml flasks were used)

b. Suitable conditions of co-treatment of microbes and other ingredients

To elucidate the fermentation property of peat treated with EM-1, firstly 3% of molasses along with EM-1(5%) was added to the dried and pulverized peat, and then cultured under 60-70% of water content. As a result, the growth of lactic acid bacteria was increased with incubation time, but the pH of cultures was reduced. However, there was no difference in humic acid contents. Thereafter, the inoculation of various beneficial microbes such as NFB, PSB, Lactobacilli, and P-K decomposing bacteria into the organic substrates pre-fermented with EM-1, improved the growth of total microbes and available humic acid content (Table 4). Hence, the inoculation of compound microbes into the medium pre-fermented with EM-1 and its refermentation improved the growth of each microbe, doubling the soluble humic acid content.

Table 4. Microbial Population and Humic Acid Content after Inoculation of Various Microbes into the Organic Substrates Pre-fermented with EM-1

Treatment	Microbial Population ($x10^8$ cells/g)						Soluble Humic Acid (%)	
	Total Microbes		NFB		*Lactobacilli*			
	1st day	2nd day	1	2	1	2	1	2
Control	0.1	0.2	-	-	-	-	0.9	0.95
Compound Microbes	9.39	15.3	2.05	4.57	3.23	4.2	0.9	2.0

The addition of urea with different concentrations into EM-1 stock solution showed the survival of *Lactobacilli*, although the concentration of urea was high. Morevoer, the formation of white film of yeast on the surface of cultures was also observed, though the concentrations of urea were as 5-7% (Table 5).

Table 5. Effect of Urea Concentration on the Growth of Lactobacilli

Index	Urea Concentrations (%)							
	0	3	5	7	10	20	30	50
Lactobacilli($x10^8$ cells/g)	4.48	4.38	4.02	3.23	2.75	2.46	1.54	0.19
Formation of yeast	++	++	+	±	-	-	-	-

(measurement date; at 3 days after the incubation)

In case of NFB, when 5% of urea concentration was added, there were little changes in its survival, although there was a decrease with 10% of urea (Table 6). Particularly, the ammonia (NH_3) gases were produced with more than 10% of urea.

Table 6. Effect of Urea Concentration on the Growth of N_2-fixing Bacteria

Index	Urea Concentrations (%)						
	0	5	10	20	30	40	50
NFB($x10^8$ cells/g)	193	133	43	3.0	1.25	1.0	0.5
Formation of NH_3	-	-	+	+	+	++	++

(measurement date ; at 3 days after the incubation)

2. Physico-chemical Properties of Multi-ingredient Compost and its manufacturing process

a. *General property of multi-ingredient compost*

This compost is considered as a neutral (pH=6.5). The main nutrients contents of this compost are given in Table 7.

Table 7. Main Nutrients of Multi-ingredient Compost

Nutrients	Contents	Nutrients	Contents
Total-N(%)	7.54	Total-P_2O_5 (%)	0.09
Mobile-N(mg/100g)	159	Mobile- P_2O_5 (mg/100g)	23.0
NH_3-N (mg/100g)	155	Total-K_2O(%)	2.04
NO_3-N (mg/100g)	0.15	Mobile- K_2O(%)	7.2

It could be also considered that the multi-ingredient compost characterize as mineral fertilizer, due to its moderately high humic acid contents.

b. Technical process for production of multi-ingredient compost

For ensuring the efficacy of microbial fertilizer, it is advisable that the inoculation of microbes with high activity should be done in groups, but not in a single strain. One must also resolve the way to enable the inoculated microbes to develop in soil, destroying the equilibrium of indigenous microorganisms that maintained for long time (Higa and Parr, 1944). Therefore, the culture properties of inoculants must be elucidated, and the organic substrates should be processed for increasing their adaptability.

In view of this, we established the manufacturing method of multi-ingredient compost constituted by four elements such as organic and inorganic materials, microelements and EM (Figure 2). This is one of bio-active compound fertilizer.

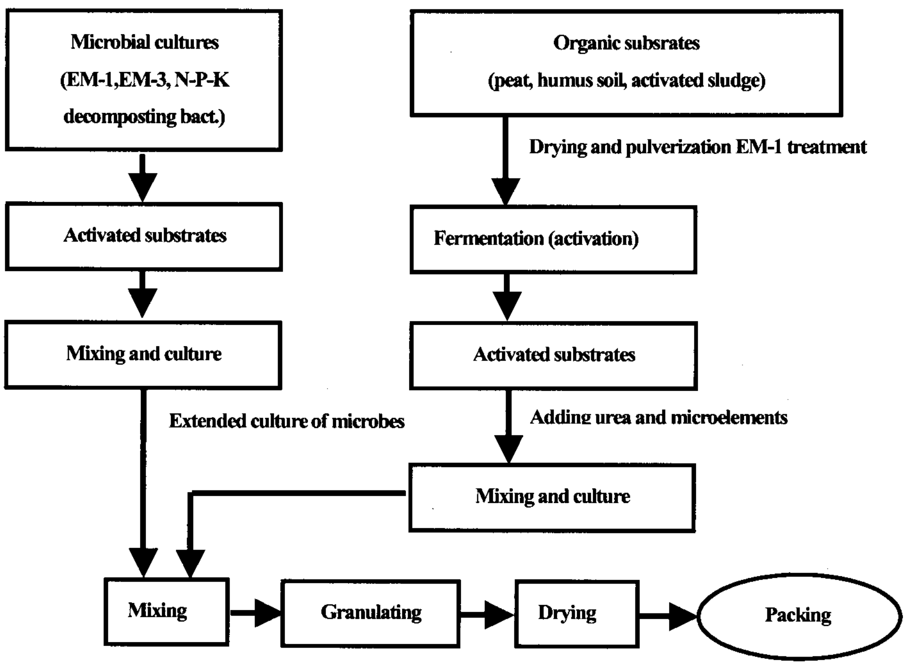

Figure 2. Manufacturing Process of Multi-ingredient Compost

The experimental results showed that the intermediate fermentation period was only for two days maintaining about 1010 cells/g of NFB. The microbial culture could be re-inoculated after drying.

On the basis of these results, the field experiments of small plot and large scale area of 100 ha in paddy rice are now undertaken to test the effect of EM solid fertilizer. The most important aspect for making this compost is to process the organic materials so that the activity and growth of microbes on them, its adaptability in soil could be improved. The use of EM is a good way in resolving this problem.

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