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Production of organic compost from mushroom producing substances waste and tested for Kangkong organic cultivation

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Organic compost from mushroom producing substrate waste was produced to 6 kinds of compost. The data of all kind organic compost were analyzed and reported as follws:- pH 7.79, EC 95553 us/cm, organic matter 45 %, P 3,008 ppm, K 14,195 ppm, Ca 5860 ppm, Mg 2834 ppm, Fe 48.53 ppm, Mn 55.63 ppm, Zn 53 ppm. Each organic compost was testred for organic production of kangkong and resulted to promote the growth of kangkong in the field at 23 days. The total yield in 4 square meters of each experimental plot showed that organic compost using bio-decomposer produced from mushroom producing substrates waste in formula 1 gave significantly highest yield of 10.43 kg and followed by applying F2, F3, F4, F5 and F6 which were 8.87, 8.80, 7.53, 9.57 and 9.17 kg, respectively when compared to application of the organic compost that not used bio-decomposer (control), the yield was only 6.40 kg. With this, the organic compost using bio-decomposer produced from mushroom producing substrates waste in different formula as F1, F2, F3, F4, F5 and F6 could increase in yield of 38.63, 27.84, 25.58, 15.00, 33.12 and 30.20 %, respectively.

Key words: Organic compost, mushroom, bio-decomposer.

Introduction

Application of chemical fungicides has been recognized to cause environmental pollution and leave chemical residues in the soil, water and agricultural products, and it is known that continuous use of chemical fungicides leads to the development of resistance in the pathogen. Biological control of plant pathogens has successful provided a relatively recent strategy for integrating with other control measures (Soytong, 2004). It could reduce the heavy use of chemical fungicides, improving agro-ecosystem and maintain natural balance. There are several reports on the potential use of biological

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control agents against plant pathogens. *Chaetomium* spp. is one of the strictly saprophytic antagonists against several plant pathogens, e.g. *Phytophthora palmivora* and *Colletotrichum gloeosporioides* (Noiaium and Soytoong, 1997; Prechprom and Soytong, 1997 and Sod saard and Soytong, 1997). The biological products have been developed as biofetilizer, biohumus, bioinsecticide according to research findings as reported by Soytong as the agricultural input for good agricultural practices (GAP), pesticide-free production (PFP) and organic crop production (Charee, 2005; Chaiwat, 2004).

Soytong (2004) stated that Thailand is the one of the research leader on biological products for agriculture producing good agricultural practices (GAP) of crop, pesticide-free production and organic crop using biological integrated pest management (Bio IPM). The aim is to decrease or atop the use of toxic chemical pesticides. Research and development has performed with the several known outstanding scientists in the field of microbial biotechnology in agriculture to meet the philosophy as follows: high microbial activity, high organic matter, high natural resources, high environmental protection and high yield and safety food. It has been interested in biological control among scientists over 20 years to seek the new strategic for diseases and pest control to decrease the usage toxic chemical pesticides. Research and development of microbial products for bio-agriculture have been conducted for over 15 years. These are now successfully being applied to promote good agricultural practice (GAP), pesticide-free production (PFP), commercial scale organic farms, and in combined applications for integrated pest management (IPM). Microbial products are now used to reduce damage to several economic plants in Thailand, Laos, Cambodia, Vietnam and P.R. China., and to decrease toxic chemicals in agricultural products and surrounding environment for sustainable development. The microbial products used for bio-agriculture are biological organic fertilizers (microbial fertilizers), biological humus, liquid organic microbial fertilizers to improve soil fertility and promote plant growth and biological fungicides (Ketomium) for disease control. This research finding aimed to prove those microbial products used for organic crop production in the field. The aim was to evaluate organic compost from mushroom producing substrate waste for organic vegetable production of kangkong or water convolvulus (*Ipomoea aquatica*).

Materials and methods

Production of organic compost from mushroom producing substrates waste

The waste from mushroom production was performed by composting with bio-decomposer which contains The bio-decomposer contains:-

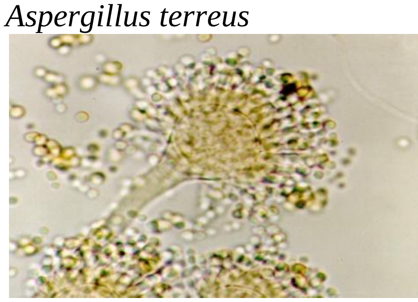
Aspergillus oryzae, *Aspergillus terreus* , *Emericella nivea*, *Pseudoeurotium zonatum*, *Mucor* sp., *Penicillium* sp., *Trichoderma hamatum* and *Trichoderma harzianum* to stimulate fermentation process to be compost. Six formulations were done as follows:-

Formula 1 = mushroom producing substrates waste from oil palm
Formula 2 = mushroom producing substrates waste from rice straw, cotton, cassava
Formula 3 = mushroom producing substrates waste from sawdust 1
Formula 4 = mushroom producing substrates waste from saw dust 2
Formula 5 = mushroom producing substrates waste from saw dust 3
Formula 6 = mushroom producing substrates waste from saw dust 4

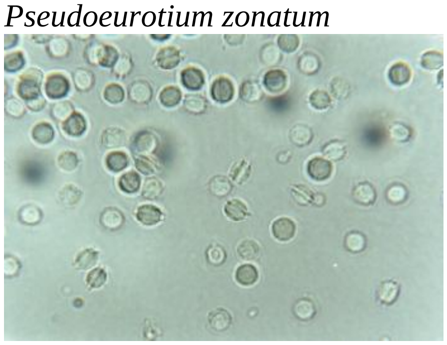
Bio-decomposer is a microbial product to stimulate for compost production which consists of beneficial microorganism including specific fungi, bacteria and actinomycetes that they can produce several kinds of enzymes e.g cellulose, amylase, hemicellulase, lignin and protease etc.

Aspergillus oryzae

Aspergillus terreus



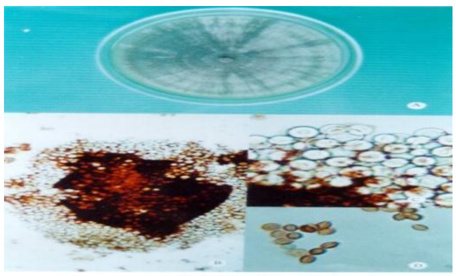
Pseudoeurotium zonatum



Mucor sp

Trichoderma hamatum *Trichoderma harzianum*

Emericella nivea *Penicillium variabile*



It can be used to degrade the organic substances like plant and animal debris in fermentation process to produce compost, and used as bio-decomposer. For compost production, bio- decomposer 200 g/20 L of water, then spray over organic materials e g the mixed of plant and animal debris, dung or manure in fermentation process. Thereafter, let the air go through the composting to reduce the heat by mixing again at 7 days until it become completely degraded to be composted.

Procedure and composition

1. Biodecomposer 20 0g
2. Plant debris eg mushroom waste, rice straw 1, 000kg
3. Animal dung 200 kg
4. Urea 1 kg
5. Lime 1 kg

First shelf: Put plant debris and moistened it for the first base (about 250 kg), Put 50 kg of animal dung, 250 g urea, 250 g lime, 5 L of bio-decomposer.

Second shelf: Put plant debris and moistened it for the first base (about 250 kg), Put 50 kg of animal dung, 250 g urea, 250 g lime, 5 L of bio-decomposer.

Third shelf: Put plant debris and moistened it for the first base (about 250 kg), Put 50 kg of animal dung, 250 g urea, 250 g lime, 5 L of bio-decomposer.

Four shelf: Put plant debris and moistened it for the first base (about 250 kg), Put 50 kg of animal dung, 250 g urea, 250 g lime, 5 L of bio-decomposer.

Adding water to keep moist every day at the middle of compost decomposing and mixing together after 15 days for 2 times.

All would degrade into small pieces and become compost, Mixing and drying to 30 % moisture content.

The process of fermentation to produce compost was completely degraded for 30 days. Six compost formula were analyzed plant available nutrients.

Testing compost produced from mushroom producing substrates waste for plant growth.

Organic compost from mushroom producing substrate waste was tested for plant growth of kangkong or water convolvulus (*Ipomoea aquatica*) in the field as organic crop production. The experiment was done by using randomized complete block design (RCBD) with four replications. Treatments were as follows:- Treatment 1 = Compost Formula 1 (F1), Treatment 2 = Compost Formula 2 (F2), Treatment 3 = Compost Formula 3 (F3), Treatment 4 = Compost Formula 4 (F4), Treatment 5 = Compost Formula 5 (F5), Treatment 6 = Compost Formula 6 (F6), and Treatment 7 = no-compost application (control). Plant bed or experimental plot was 1x4 m. The total of experimental plots were as 28 plots and applied 5 kg compost in each plot. All treatments were sprayed Ketomium – biofungicide for disease control at 20 g/20 L of water and bio-insecticide 20 g / 20 L of water at 7 day interval until harvest. Data were collected as plant fresh weight (cm), plant fresh weight (g). Increased growth was calculated using compost application treatment – non-compost application treatment/compost application treatment X 100.

Results and discussions

Quality of compost

The organic compost was produced from mushroom producing substrate waste in six formula by using bio-decomposer contains:- *Aspergillus oryzae, Aspergillus terreus*, *Emericella nivea, Pseudoeurotium zonatum*, *Mucor* sp., *Penicillium* sp., *Trichoderma hamatum* and *Trichoderma harzianum* to stimulate fermentation process to be compost in 30 days. Results showed that bio-decomposer could stimulate fermentation process to be completely composted within 30 days. The bio-decomposer used in fermentation process could better degrade mushroom producing substrate waste in all six formula than the non-treated control (no use bio-decomposer). As a result, the organic composts using bio-decomposer meet the requirement of standard quality as organic fertilizer according to the Department of Agriculture, Ministry of Agriculture and Co-operatives, Thailand followed the Law of Fertilizer 2008 in Thailand and fertilizer Acts from Ministry of Agriculture and Co-operatives, especially require organic matter over 20 % by weight (DOA, 2008). All six formula of F1, F2, F3, F4, F5, and F6 organic compost contain high organic matter of 54.7, 51.9, 55.5, 59.6, 51.2 and 59.8 %, respectively (Table 1).

Table 1. analysis of available plant nutrients from compost produced from mushroom producing substrates waste

Available nutrients	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**
pH	7.22	7.27	8.47	8.61	8.33	6.85
EC (us/cm)	6050	12350	10180	9320	10720	8700
OM (%)	54.7	51.9	55.5	59.6	51.2	59.8
P (ppm)	2711	3222	2952	2410	2867	3886
K (ppm)	10344	18932	15919	13262	13063	13652
Ca(ppm)	5445	5424	4016	5323	6898	8057
Mg(ppm)	2361	2345	2793	3215	3120	3175
Fe(ppm)	43	34	54	53	43	62
Mn(ppm)	29	57	48	56	48	94
Zn(ppm)	55	71	75	61	59	64

Testing compost produced from mushroom producing substrates waste

Organic compost using bio-decomposer produced from mushroom producing substrates waste of six formula as F1, F2, F3, F4, F5 and F6 were used to apply for cultivation of organic kangkong production in the field. Result showed that the organic compost F1, F2, F3 and F4 gave significantly plant highest of 29.07, 28.97, 27.00 and 27.23 cm, respectively and followed by applying organic compost F5 and F6 (25.83 and 21.70 cm) which significantly different at P=0.01 when compared to the organic compost that not used bio-decomposer (control), the plant height was only 16.83 cm. at 23 day harvesting time (Table 2 and 3). As a result, data collected as plant height starting from eighth day until 23 days harvesting time that showed the organic compost using bio-decomposer produced from mushroom producing substrates waste of six formula as F1, F2, F3, F4, F5 and F6 gave better plant height than to organic compost that not used bio-decomposer (control). Moreover, Chularak (2002) reported a similar result using bio-decomposer to make organic compost from filter cake from sugarcane factory and the compost could increase in yield of kale.

Table 2. Plant height after apply organic compost produced from mushroom producing substrates waste from 8-15 days

Treatments	8	9	10	11	12	13	14	15
F1	1.34 a[1]	3.67 a	5.01 a	6.62 a	8.33 a	9.93 a	11.63 a	13.50 a
F2	1.19 a	3.53 a	4.71 a	6.21 a	7.97 a	9.57 a	11.63 a	13.67 a
F3	1.33 a	3.64 a	4.60 a	6.03 a	7.53 a	9.00 a	10.30	12.13 a
F4	1.32 a	3.53 a	4.68 a	6.10 a	7.50 a	9.00 a	10.50 a	12.47 a
F5	1.24 a	3.60 a	4.41 a	5.55 a	6.67 a	8.07 a	9.30 ab	10.90 ab
F6	1.35 a	3.07 ab	4.81 a	6.13 a	7.50 a	8.93 a	10.43 a	12.17 a
Control	0.93 b	2.02 b	2.84 b	3.64 b	4.53 b	5.47 b	6.40 b	7.63 b
CV (%)	8.33	13.36	9.95	10.88	11.68	12.41	12.30	14.29

[1]Mean of four replications. Means followed by a common letter in each column were significantly different by DMRT at P=0.01.

Table 3. Plant height after apply organic compost produced from mushroom producing substrates waste from 16-23 days

Treatments	16	17	18	19	20	21	22	23
F1	15.17 a[1]	16.67 a	18.47 a	21.23 a	23.53 a	24.90 a	27.10 a	29.07 a
F2	15.17 a	17.30 a	19.27 a	17.93 a	23.27 a	24.63 a	26.43 a	28.97 a
F3	13.57 a	14.73 ab	16.63 ab	19.27 a	20.73 ab	22.73 ab	24.77 ab	27.00 a
F4	14.13 a	15.20 ab	17.00 ab	19.23 a	21.10 ab	22.87 ab	24.33 ab	27.23 a
F5	12.27 ab	13.50 ab	15.37 ab	17.63 a	19.43 ab	21.13 ab	22.90 ab	25.93 ab
F6	13.87 a	15.00 ab	16.53 ab	18.83 a	19.87 ab	21.97 ab	23.80 ab	21.70 ab
Control	8.60 b	9.50 b	10.90 b	12.27 a	13.17 b	14.27 b	15.27 b	16.83 b
CV (%)	14.24	14.83	16.44	18.22	15.98	16.13	15.13	15.16

[1]Mean of four replications. Means followed by a common letter in each column were significantly different by DMRT at P=0.01.

It is clearly demonstrated that all six formula of the organic compost using bio-decomposer produced from mushroom producing substrates waste gave significantly higher yield or plant fresh weight than the non-treated bio-decomposer (control) as seen in Table 4. Result showed that applying organic compost using bio-decomposer produced from mushroom producing substrates in F1, F3 and F5 gave significantly highest in yield of 13.03, 12.37 and 14.13 g per plant and followed by F2 and F6 which were 10.27 and 10.70 g, respectively which highly significant different at P=0.01 when compared to the organic compost that not used bio-decomposer (control), the yield was only 3.43 g/plant. The total yield in 4 square meters of each experimental plot showed that organic compost using bio-decomposer produced from mushroom producing substrates waste in formula 1 gave significantly highest yield of 10.43 kg and followed by applying F2, F3, F4, F5 and F6 which were 8.87, 8.80, 7.53, 9.57 and 9.17 kg, respectively when compared to application of the organic compost that not used bio-decomposer (control), the yield was only 6.40 kg.

With this, the organic compost using bio-decomposer produced from mushroom producing substrates waste in different formula as F1, F2, F3, F4, F5 and F6 could increase in yield of 38.63, 27.84, 25.58, 15.00, 33.12 and 30.20 %, respectively. This similar result was reported by Apiradee (1992), Kumar and Goh (2000) and Jindarat *et al.* (2006) who stated that the good quality of organic compost could enhance the plant growth and increase in yield as in kangkong or water convolvulus (*Ipomoea aquatica*), Kale (*Brassica oleracea* var *albograbra*), Pakchoi (*Brassica chinensis* var. *parachinensis*) and Chinese cabbage (*Brassica pekinensis*).

It is suggested that the organic compost using bio-decomposer produced from mushroom producing substrates waste using bio-decomposer could further promote to apply in rice, papa rubber, coffee, tea and vegetables.

Table 4. Yield (plant fresh weight) after apply organic compost produced from mushroom producing substrates waste for 23 day harvesting time

Treatments	Yield(g)	Increased yield (%)	Total yield of 4 square meter (kg)	Total increased yield (%)
F1	13.03 a[1]	70.67	10.43 a	38.63
F2	10.27 ab	67.47	8.87 ab	27.84
F3	12.37 a	72.27	8.60 ab	25.58
F4	6.77 bc	50.66	7.53 ab	15.00
F5	14.13 a	75.75	9.57 ab	33.12
F6	10.70 ab	67.94	9.17 ab	30.20
Control	3.43 c	-	6.40 b	-
C.V.(%)	16.79	-	15.07	-

[1]Mean of four replications. Means followed by a common letter in each column were significantly different by DMRT at P=0.01.

References

Apirudee Imeuimp (1992). Status of agricultural soil before co-operate with soil and fertilizer project. J. Soil Development 319(29):33-40.

Charee pumsing (2005). Cultivation of *Brassica olreacea* var. *albograbra* in Good Agricultural Practices (GAP), Pesticide-Free Production (PFP) and Organic Agriculture (OA). Special Problem. Department of Plant Pest Management Technology, Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang (KMITL), Bangkok.

Chaiwat Sirikarunwong (2004). Cutivation of pakchoi for GAP, PFP and OA. Special Problem. Department of Plant Pest Management Technology, Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang (KMITL), Bangkok.pp. 94.

Churalak Talabnak (2002). Application of microbial organic fertilizer in kale. Special Problem, Faculty of Agricultural Technology. King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand.

Jindarat Cheanrung, Uthai Aramrat and Thawatchai Na Nakorn (2006). Effect of tridimite to improve physical and chemical properties in rice yield. J. Agi. Res. Tech. 24:153-167.

Kumar, K. and K.M. Gph (2000). Crop residues and management practices: effects on soil nitrogen dynamics, crop yield and nitrogen recovery. Adv Soil Science 68:197-319.

Noiaium, S. and Soytong, K. (1997). Integrated biological control of mango var. Choakanon. Proc. of the Sixth International Mango Symposium. Pattaya, Thailand, pp. 1-13.

Prechaprome, S. and Soytong, K. (1997). Integrated biological control of durian stem and root rot caused by *Phytophthora palmivora*. Proc. of the First International Symposium on Biopesticides. Thailand, October 27-31, 1996, pp. 228-237.

Kaewchai, S., Soytong, K. and Hyde, K.D. (2009). Mycofungicides and Fungal Biofertilizers. Fungal Diversity 38:25-50.

Sodsa-art, P. and Soytong, K. (1999). Biological control of black pepper root and basal stem rot in the field. Proc. of Symposium on Biological Control in the Tropics, MARDI Training Centre, Malaysia, 18-19 March 1999, pp. 68-70.

Soytong, K. (2004). Handbook of Biological Agriculture.KMITL Press, Bangkok.

Soytong, K., Kanokmedhakul, S., Kukongviriyapan, V. and M. Isobe (2001). Application of Chaetomium species (Ketomium) as a new broad spectrum biological fungicide for plant disease control: A review article. Fugal Diversity 7:1-15.

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