Testing and adoption of EM technology in agriculture and environment in Vietnam

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Abstract.

In April 1997, Effective micro-organisms product (EM) was introduced to Vietnam the first time. Since then, many tests and researches were carried to discover the properties and applicabilities of EM on various subjects. The preliminary results on agriculture and waste treatments as well as the nature of EM are summerized as following:

-Five main groups of micro-organisms were isolated from EM product: morphologycal and physiological characteristics and effect of culture environment on their growth were studied. Beneficial mechanisms of EM were detected: production of plant growth hormones such as IAA, increased activity of nitrogenase; activity of breaking down phosphorus; and enzymatic activity of decomposing cellulose.

-Application of EM for waste treatment could improve the ambient environment surrounding the waste areas while the cost was much lower than the conventional methods. A procedure for waste treatment using EM product has been proposed and applied on large scale in several provinces and cities in Vietnam.

-Application of EM (in solution form and bokashi) for rice, maize. soybean and vegetables increased crop yield and shortened growth duration. EM could substitute for one fourth to one third quantity of chemical fertilizer without affecting yield. EM exhibited positive effect on the development of beneficial soil microbes and increased the soil phosphorus availability and humus content.

-Application of EM in poultry and hog raising promoted growth and improved resistance, thereby increasing meat yield and shortening the raising period and consequently improving economic efficiency. It was notable that EM exercised good effect in preventing white diarrhea syndrome caused by E.coli and Salmonella. Using EM also improve the environment in the raising sheds.

Introduction.

EM (effective micro-organisms) technology has been introduced to Vietnam since April 1997. The Ministry of Science, Technology and Environment has initiated a state level research project to comprehensively assess the nature, role and applicabilities of EM in agriculture and waste treatment in Vietnam. Twenty two scientists from seven training and research institutes have involved in this research project, i.e. Hanoi Agricultural University, Hanoi National University, Vietnam-Japan Technology Development Center. Vietnam Agricultural Science Institute, National Institute of Plant protection. Institute of Veterinary and Institute of Chemical Industry. After 18 months researching and testing the EM product, the initial results showed positive effects.

Summary of Research Results Using EM.

Basic research.

Component and nature of major micro-organisms of EM were studied by using the standard media and current methodology. 5 groups of micro-organisms was isolated:

-Photosynthesis bacteria consists of QH4 and QH9 which belong to Rodopseudomonas sp.

-Lactic acid bacteria (SH2 and LH1). According to Bergey, LH1 belongs to Lactobacillus and SH2 is Streptococcus.

-Actinomycetes: X1 and X2. According to Shirling Gottied and Gauze X1 belongs to Streptomyces macrosporeus and X2 belongs to Streptomyces gougeroti.

-Fungi: AH4 and AH5 species. According to Raper and Fewell AH4 belongs to Aspergillus. AH5 belongs to Penicillium.

-Fermenting fungi: Na and Nb. Na belongs to Saccaromyces cerevisae. Nb belongs to Candidalutis.

The characteristics of physiology, biochemistry, morphology, culture condition, growth and development of these isolated micro-organisms are continued to study.

-The test result showed EM has no toxic when applied for rats. Coliform salmonella, Shigella, Pseudomonas aeruginosa. Staphylococcus aureus were not found.

We already discovered some mode of action of mechanisms of EM such as the appearance of IAA (a growth regulation), nitrogen-fixing bacteria and access their activities by enzyme nitrogenase and enhanced celluloze-decomposing bacteria.

Waste treatment and garbage processing.

Solid waste treatment.

The most common measure for treating wastes and garbage in Vietnam is to bury them under the ground and spray over the dump surface with powered lime and insecticides in order to restrict stinks and flies. This method is clearly not effective. These garbage dumps still become harmful and dangerous sources of pollutants for surrounding environment and underground water. The daily life of the people living near these garbage dumps are seriously effected.

When applied EM, the polluted environmental problem which cause the social and political stress were solved.

At the present, the technological procedure using EM for burying garbage treatment are being applied at the Caudien garbage treatment enterprise. The procedure is:

-Leveling tamping and pressing garbage with caterpillar bulldozer for achieving a density of 550-700kg/cubic meter, spraying EM solution of fresh garbage with a promotion of 5ml/ton of garbage.

-After each layer of garbage of 0.8-1.0 m thickness, a layer of EM bokashi (compost produced from garbage fermented by EM) is spreaded with a proportion of 0.1 kg/square meter, then garbage is covered by 10cm thick layer of soil.

-Lime, insecticides (including chemicals for killing mosquitoes) are not used.

Applying this procedure brings remarkable economic efficiency. The cost pay for treating reduced about 100$/ton of garbage compared to the old one without using EM.

Table 1 and 2 show the results after applying EM in treating for garbage.

Table 1: Gas content in experimental garbage basins (24 m^3)(anaerobic condition)

Date of Measurement	Method	Gas contents (mg/m^3)			
		CO	SO_2	H_2S	CH_4
6/9/1998	Without EM	0.2	3.76	0.36	1.08
	With EM	0.2	3.10	0.26	1.40
15/9/1998	Without EM	0.39	0.20	0.52	0.057
	With EM	0.28	0.20	0.15	0.015
24/9/1998	Without EM	0.1	0.10	0.12	0.02
	With EM	not detected	0.05	not detected	0.007
23/10/1998	Without EM	0.10	0.08	0.2	0.020
	With EM	not detected	not detected	not detected	0.005

Table 2: Analysis of gas environmental in Taymo dump (February 1998)

Site of Measurement	Lot No.	CO_2 (mg/m^3)	SO_2 (mg/m^3)	H_2S (mg/m^3)	Suspended dust TSP (mg/m^3)	CH_4 (mg/m^3)
Fresh garbage not treated with EM	1	2.440	2824	0.772	2.886	not detected
	2	2.397	2105	0.757	2.652	not detected
	3	2.838	2176	0.824	2.230	not detected
	4	2.120	2090	0.880	1.858	not detected
	5	2.956	1988	0.536	1.206	not detected
	average	2.550	2360	0.754	2.166	not detected
Garbege treated with EM	1	1.137	0.0132	not detected	0.192	not detected
	2	1.040	0.0146	not detected	0.192	not detected
	3	1.496	0.0120	not detected	0.190	not detected
	4	1.180	0.0120	not detected	0.194	not detected
	5	1.328	0.0440	not detected	0.192	not detected
	average	1.236	0.0192	not detected	0.192	not detected

EM treatment for waste of agricultural product processing factory.

Processing export company locates in Vinhtuy-Thanhtri-Hanoi. The foul smelling of animal bones collected from everywhere polluted seriously surrounding environment. Applying EM for bones processing showed that:

- The malodors of bones stored in the ponds were suppressed after 1-2 days when dipped these bones into EM solution 1: 250 diluted in 3-5 minutes.
- For fresh bones, using EM with the same diluted concentration delayed the oozing of malodors for long time compared with the control without EM treatment. The foul smell appeared just after 2 days. Therefore, it is necessary to treat bones collected before or after entering the factory.

Table 3: The quality of bones after treating with EM.

Content (%)	Experimental bone on 7/12/98	The best bone sample on 23/6/98 and 3/10/98			Average value of 12 bone samples from23/6/98 to 6/11/98
N	4.46	3.96	4.21	3.55	3.74
P_2O_5	25.28	26.86	25.78	25.27	23.31

The result on table 3 indicates that using EM in processing procedure not only suppressed the appearance of malodors but also increased the contents of N and P_2O_5 resulting to the quality of product was improved.

Research on Agricultural Crops.

Rice.

A number of field and greenhouse experiments were conducted at Hanoi Agricultural University in which EM solution and bokashi was applied. The are of experimental plot in the greenhouse is $1m^2$ and in the field is $450m^2$. Using a randomized complete block design (RCBD) with 4 times replications per treatment.

Experiment 1: effect of EM (dilution type) on CR203 variety

Treatments were as follows:

T1: 6ton organic manure +100N+60 P_2O_5 +40 K_2O

T2: 6ton organic manure +50N+30 P_2O_5 +20 K_2O+ EM (6 liter/ha)

T3: 6ton organic manure +EM (6 liter/ha)

Table 4: The effects of EM on growth, development and yield of CR 203 variety

Treatment	Height of seedlings (cm)	Height of plant (cm)	Effective culms / Plant	Effective grains / head	Weight of 1000 Grains (g)	Time that 50% flowering (days)	Yield ton / ha
T1	26.5	89.0	4.1	96	24.0	99	4.20
T2	26.5	88.3	4.5	112	24.0	94	4.42
T3	26.5	89.3	3.8	110	24.2	90	4.45
LSD (5%)			0.68				0.12
T1	27.0	94.5	4.65	96	23.5	93	3.92
T2	27.0	92.6	5.20	112	23.7	88	4.41
T3	27.0	93.4	5.22	110	23.9	80	4.21
LSD (5%)			0.45				0.46

Table 5: Economical efficiency of EM on CR203 variety

Treatment	Yield (ton / ha)	Total income (10^6VND)	Expence (10^6VND)			Profit (10^6VND)
			Total output	Labour	Materials	
1	3.92	7.056	5.20	3.24	1.96	1.856
2	4.41	7.938	5.55	3.55	1.97	2.388
3	4.21	7.578	4.31	3.51	0.08	3.263

Table 6: The effect of EM on yield and grain

Treatment	Green house plots				In the field		Grain quality		
	Theorical yield		Attained yield		Attained yield				
	100kg / ha	% compared with control	100kg / ha	% compared with control	100kg / ha	% compared with control	% dry matter	% protein	% starch
1	68.6	100.0	52.3	100.0	54.8	100.0	90.71	5.58	59.80
2	83.6	105.7	54.1	103.0	55.9	102.0	91.23	5.83	60.22
3	67.5	98.4	51.6	98.7	53.7	98.0	91.14	5.82	59.54
4	75.1	109.5	55.2	105.5	58.6	106.9	91.51	5.90	60.91
5	82.5	120.3	59.4	113.6	60.8	110.9	91.72	6.00	61.53
6	79.1	115.5	57.3	109.6	59.0	107.7	91.53	5.90	60.30
7	85.4	124.5	60.8	116.3	63.3	115.5	92.80	6.03	61.84
8	88.3	128.7	62.0	118.5	65.2	119.0	92.88	6.06	62.86
LSD 0.05			1.16		2.1				

Table 4,5 shows the results on growth, development, photosynthesis and yield components at different experimental treatments. Table 6 shows the effect of EM on yield and grain quality of C70. The data showed that;

- -EM exerted influence not only on the growth, development and yield but also on grain quality. On CR203 variety, especially at the second crop, the yield increased from 290-490 kg/ha (8.0- 15.5%). EM applied showed a positive effect on the grain quality. The crude protein content of grains improved from 0.224 to 0.48 and starch content from 0.42 to 3.06.
- -Using EM reduced the amount of applied fertilizer without affecting the final yield.
- -The growth duration due to EM application were shorten from 5~13 days (in summer crop). This brings a remarkable benefit for the next winter crop.
- -EM applying for rice was profitable, with the highest return when 2 tons of EM bokashi and spraying EM 0.1% were used.
- -The prior observation indicated EM application could retract the pest and pathogen, especially yellow leaves.

Soybean

EM exercised good influence on growth, development and grain yield and quality of soybean cv.DT 84 grown during spring-summer season in Vietnam. Application of 1tons of EM bokashi combined with spraying 0.1% EM increased grain yield by 450 to 530 and return from 3.041.000 to 3.321.000 VND per hectare.

Maize and vegetable

On maize and vegetable, the first results showed that EM application increased the yield components and accumulation process. The amount of fertilizer applied was reduced when EM was used and yet the yield was the same. Using EM also reduced the damage of insect pests and infection of pathogen.

Effect of EM on the cultivated soil

The effects of EM on micro-organism system in the soil, root area as well as the combination abilities with other benefit micro-organisms and the changes of chemical properties during the time applying EM on rice and maize field after 3 crops were shown in table 7 and 8.

Table 7: Some chemical compositions of cultivated soil after 3 experimental crops.

Treatment	Humus (%)	N(%)	P_2O_5 (%)	K_2O (%)
-control (without EM)	0.90	0.08	0.11	0.66
-with EM	1.95	0.11	0.10	0.63
-EM+nitrogen fixing bacteria + phosphogenous decomposing bacteria	2.34	0.17	0.11	0.69
- Nitrogen fixing bacteria + phosphogenous decomposing bacteria	1.37	0.12	0.12	0.63

Table 8: The effects of EM on the existing of major microorganisms in the soil after 3 crops (average / g soil)

Treatment	Total microorganisms ($x10^7$)		Azospirillium ($x10^4$)		Azotobacter ($x10^3$)		Phosphorous Decomposing ($x10^3$)	
	Soil	Root area	Soil	Root area	Soil	Root area	Soil	Root area
T1	7.3	18	1.8	2.6	0.6	0.0	0.3	13
T2	65	531	282	548	1.5	0.48	2.5	44
T3	77	675	439	973	1.7	0.52	4.7	68
T4	58	458	311	625	1.5	0.47	2.1	39

T1; control (without EM)

T2; with EM

T3; EM + nitrogen fixing bacteria + phosphogenous decomposing bacteria

T4; Nitrogen fixing bacteria + phosphogenous decomposing bacteria

EM on plant protection.

The effects of EM on the appearance and development of pests and pathogen on the yield of

some kinds of food and fruit crops were studied. The result concluded on table 9 and 10 showed that:

- -EM could control the damage level of pest and pathogen.
- -EM enhanced the development, long-life of leaves and strengthen the health of the plants.
- -When applied EM for cucumber, the same yield could still be attained even pest and preventive chemicals were not used. Therefore, using EM can be considered as a pest integrated management for brassica and cucumber.
- -Using EM also ensured the safe of environment. the human health and food safety.

Table 9: The density of cut worms on the cabbage field at different treatments (number of cut worms / plant)

Treatments	10 days after planting	31 days after planting	36 days after planting	43 days after planting	51 days after planting	58 days after planting
EM+EM5 +FPE	16.0	13.0	23.7	5.3	113.0	125.0
Spraying EM5	19.0	16.0	17.7	5.7	73.0	81.3
Spraying EM+FPE	18.3	19.0	17.7	9.0	93.3	107.0
IPM	17.3	14.7	23.3	4.3	62.3	15.3
Control	24.3	62.0	72.3	20.0	145.7	206.7

Table 10:Density of cut worms, rate of cucumber leaves infected (days after planting)

Treatments	Diamond Moth (No. / plant)		Leaves infected by flies (%)		% infected leaves 43 days	% plants died after 38 days
	31 days	43 days	31 days	43 days		
EM + EM5+ FPE	2.7b	2.8ab	27.4b	25.5b	5.4ab	27.4ab
Spraying EM5	2.7b	2.9ab	26.8b	24.1b	6.4b	29.2ab
Spraying EM + FPE	3.0b	2.7ab	27.7b	23.4b	5.9ab	30.3b
IPM	2.0a	2.3a	20.2a	16.7a	4.9a	26.7a
Control	3.3b	3.0b	27.0b	22.5b	6.0ab	29.5ab

EM on veterinary and husbandry.

On pig production: an experiment was conducted with 10 pigs fed with and without EM treated for period from being weaned to slaughtering. The results showed on table 11.

Table 11 :Accumulate weight increasing of pigs (kg/pig)

Treatment	Control (n=5)			Experiment (n= 5)			Comparison between Control & treatment	P
	X ±mx	Sx	CV%	X ±mx	Sx	CV%		
Start	14.10	1.34	9.52	14.04	1.98	14.13		
1st month	19.08	1.15	5.81	22.40	4.63	20.66	113.13	***
2nd month	27.80	3.56	12.82	33.30	7.53	22.61	116.91	***
3rd month	38.00	7.35	19.34	41.80	8.44	20.19	110.00	***
4th month	54.10	8.31	15.36	56.80	13.01	22.90	105.00	***
Average							111.26	

*** difference at P< 0.001

On broiler chicken production: The experiment was using 70 chicken. The chicken at control treatment were fed with normal food (T1). Half of the rest fed food with 0.1% EM added to drinking water (T2). The other were fed with bokashi (T3). The results on pigs and chicken showed that:

- -Adding EM at 0.1% concentration into drinking water or processing food enhanced the better growth and development of pigs and chickens.
- -Using EM improved the food consume of animal, increased the health resulting to higher efficiency in animal raising. The environment in and around the sheds was clearly cleaned.
- -Physiology and chemical index of blood, the quality of meat of pigs and chicken in experiment were increased.

Table 12: The weight of experimental chickens (g/chicken)

Age (week)	Weight (g/chicken)			Relative value comparison (%)		
	T1 (n=70)	T2 (n=70)	T3 (n=70)	T1	T2	T3
0	37.95a	37.41a	37.01a	100.00	100.00	100.00
1	135.04a	135.18a	135.03a	100.00	100.00	100.00
2	340.49b	351.13ab	360.36a	100.00	103.12	102.84
3	670.47c	697.70b	725.62a	100.00	104.06	108.23
4	1057.44c	1104.68b	1159.69a	100.00	104.47	109.67
5	1558.36c	1630.59b	1713.95a	100.00	104.64	109.98
6	2043.60c	2142.71b	2259.95a	100.00	104.85	110.31
7	2513.16c	2645.73b	2792.30a	100.00	105.26	110.31

A#. B#c with $P < 0.05$

Conclusion.

From the positive results of prior tests and experiments, EM product showed the beneficial effects on many aspects of environment, crop and animal production. The further researches need to be carried on so that the complete scientific conclusions can be confirmed and the application procedures that meet the urgent requirement of practical production can be proposed. Based on that, widely develop EM technology, consider this technique a solution for sustainable Agriculture and environment development, increasing the yield and quality of crop and animal, using effectively in waste treatment and environment protection.

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