Preliminary Study on the Function of EM for the Breeding Industry

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Abstract

The check analyses of EM in the foodstuff before and after fermentation indicated that EM improved the degradation of protein and cellulose, obviously aides the content of B vitamins, made the acidification degree of the foodstuff and animal alimentary canal higher, checked the nocuous bacteria, such as *colibacillus*, increased the beneficial bacteria and improved the growth of the animal organs. All the above showed directly or indirectly the function of EM for the breeding aspects.

In recent 20 years, the Chinese animal industry has rapidly developed and the animal products have greatly been provided for. The people's living standard has been raised. At the same time, it also brings a series of problems, including:

1. More chemicals, such as antibiotic and hormone, etc., are used during the animal produce cores so that these animals produce the drug-resistance. The drug remains within the animal body to destroy the micro-ecological balance in the animal alimentary's system.
2. The environmental pollution inside and outside of the raising farm with the odor and flies can not be induced by the people and also is harmful to the animal and people's health.
3. The quality of animal products is bad with poor taste and storage.
4. The cost of intensive raising is high with low benefit so that it brings the turbulence of the development of the raising industry.

EM invented by professor Teruo Higa of Ryukyu University, Japan. It is able well to solve the above-mentioned problems on the raising aspect. After our 7 years practice, we proved that EM has the following functions on the raising industry: without or slightly using the drugs, such as antibiotic, etc.; to increase the feed conversion ratio and utilization ratio; to enforce the healthy and rapid growth of the animal and poultry; to improve the inside and outside environment of animal and poultry house with less flies; and to raise the product quality and economic effect through the decrease of raising cost. In the aquaculture industry, this method may improve the water quality.

It is well known that EM also has lots of benefits in the planting industry and environment. But some persons doubted the EM's comprehensive functions because they lacked the knowledge of the compound bacterial dosage. So they believed that it was impossible. Therefore we carried out the initial probe to the functions of EM during the practice. We found that the main functions of EM in the raising industry as follows:

1. EM fermentation improves the degradation and inversion of the feed nutrition.

The compositions of EM are effective microbes, which include rich nutritional materials. For example, photosynthetic bacteria, over 60% of their bodies are protein, besides, they have abundant nutrition: many kinds of vitamins, VB12, Folacin, Bios. *Saccharomycete*, content of Lysine is more in it than in bean, and approach the level of animal protein, content of Tryptophan in it is 7 times that of bean.

EM improves the feed nutrition value owing to the following reasons:

(1) EM fermentation enforces the degradation of the feed protein.
In 1995, we checked the feed amino acids and their total amount before and after the EM fermentation and found that 17 kinds of amino acids after EM fermentation all increased, among which Lysine, the first limited amino acid in the nutrients, increased 21%; Methionine, the second limited amino acid, increased 31%; and the total increase range was 10% - 28%. It fully indicates that EM enforces the degradation of feed protein into amino acids. Otherwise, We found that the crude protein in the natural fermented feed lost 2.1% after fermentation, but that in EM fermented feed lost slightly. Its reason maybe that the natural fermentation is caused by *colibacilllus* and corrupt bacteria, but EM rapidly controls them.

(2) EM fermentation improves the degradation of the cellulose. We measured the contents of NDF and ADF of the feed before and after EM fermentation and found that ADF increased 10.06% (Table 1). It indicated that EM improved the degradation of feed cellulose.

Table 1. Changes of the crude proteins, NDF, ADF contents in the feed before and after 4 days of the fermentation (%).

Type of feed	Crude protein content	NDF content	ADF content
Before fermentation	12.88 ± 0.11a	17.82 ± 0.28a	3.58 ± 0.11a
EM treatment	13.12 ± 0.07b	16.23 ± 1.11a	3.29 ± 0.13a
CK	12.92 ± 0.05a	16.66 ± 0.85a	3.62 ± 0.06a

The increase of the total amount of amino acids and the degradation of the cellulose raised the feed conversion and utilized ratio.

(3) EM fermentation makes the vitamins, especially B-vitamins increase. After EM feed fermentation, vitamins change as follows:

Table 2. Change of some vitamins in the feed before and after EM fermentation.

Type of feed	VA (1U/kg)	VD3 (1U/kg)	VB1 (mg/kg)	VB12 (mg/kg)	VB6 (mg/kg)
Common feed	4.62×10^2	7.02×10^4	6.2	< 2.5	26.8
EM feed	8.35×10^2	2.04×10^4	28.2	< 2.5	32.52

From the above data, it was shown that after EM fermentation, VA, VB1, VB6 in the feed obviously increased, which proved the hypothetic theory of producing B-vitamins due to the function of micro-ecological products.

2. EM fermentation makes the feed and animal canal acidify.

Table 3. Changes of the feed pH value according with the fermentation period.

Fermentation period	EM treatment	CK
Before fermentation	7.00 ± 0.05	7.04 ± 0.06
2nd day	5.78 ± 0.05	6.61 ± 0.04
4th day	4.96 ± 0.05	6.27 ± 0.05
6th day	4.60 ± 0.04	5.71 ± 0.10
8th day	4.49 ± 0.04	5.23 ± 0.06
10th day	4.46 ± 0.03	5.12 ± 0.03

The data were mean ± difference and the following tables were just the same.
During the fermented course, the feed pH value decreased according with the elongation of the fermentation period

(Table 3), and the digit of CK also decreased but the latter scale was obviously smaller than the former.

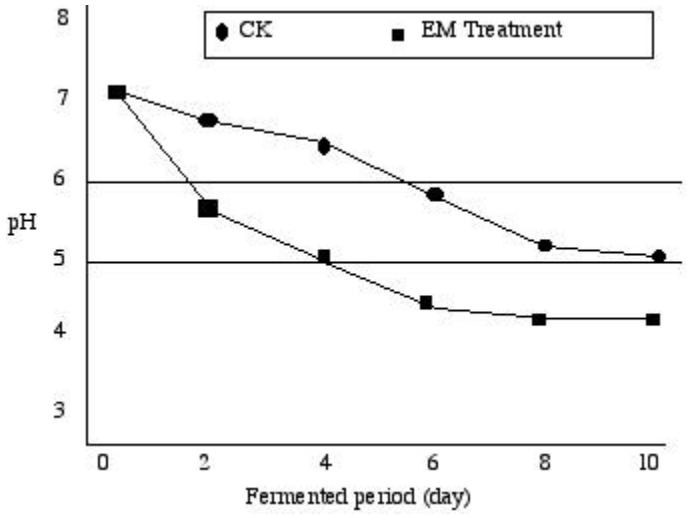

Fig. 1. Changes of the feed pH value according with the fermentation period.

During the past research, the scientists found that the acidification could activate the enzyme that was related to the metabolism of the protein and carbohydrate so as to raise their utilized ratio. The feed pH value may directly influence the pH value in the alimentary canal that also influences the functions of pancreas proteinase, gruelproteinase, carboxypeptidase, amylase, lipase, maltase and lactase. So as further to influence the total ration digestive rate , the growth of animal and inversion. For example, the suitable digestive pH value of stomach proteinase is 1.5 - 3.5 that of adult chicken glandular stomach is 4.3 - 4.6 that of gizzard is 2.8 - 3.0, and that of small intestines is 6 - 7. But the gastric acid of young animal often secretes slightly and the pH value of the digestive tract is higher so it is unfavorable for the activation of the above digestive enzymes.

Under the normal condition, the animal digestive and biochemical reactions are mainly related to the environmental pH value and the most suitable temperature. The enzyme may act or react under the specific pH value and temperature conditions. The digestive enzyme only act under the low pH value. For example, the hydrolytic starch only hydrolyzes with amylase at pH 6.5 and the glucoamylase hydrolyze the starch gum at pH 4.4. Therefore, it may help the young animal to digest.

Acidification may control the growth and propagation of the harmful microbes, e.g. *colibacillus*, etc, and stimulate the growth of the beneficial bacteria, and to supply the *colibacillus*, etc, and stimulate the growth of the beneficial bacteria, and to supply the limited acid in the stomach and to make the favorable influence of the metabolism of the energy. The organic acid, as a chelate, may improve the absorption of the minerals, e.g. Ca, P, etc. In the hind gut, the beneficial and disease-producing germs exist the delicate balance. This balance is very sensitive to pH value. During pH 4 - 5, it may benefit to the lactic acid bacteria and *streptococcus* and during pH 6 - 7, it may benefit the *colibacillus*.

3. Regulate the micro-ecological balance of the animal digestive tract.

Lots of practices have proved that EM may effectively regulate the micro-ecological balance of the animal digestive system, which may be clearly seen that EM can control the animal diarrhoea. It is well known that the animal diarrhoea is caused by the maladjustment of the intestinal bacterial groups. The proportion of the anaerobic bacteria and aerobic bacteria changes and the disease-procuring bacteria increase so as to make the animal diarrhoea. EM may check the diarrhoea. The reason maybe is that EM is the beneficial bacteria group, which enter the digestive tract to enlarge the advantageous species group of the beneficial bacteria so as to occupy the ecological position, to check the increase of the harmful bacterial group and to control the diarrhoea. From Table 4, after feed fermentation, the lactic acid bacillus increased rapidly, but the number of the decayed bacteria and *colibacillus* reduced, which fully indicated that the harmful bacteria were checked.

Table 4. Changes of the microbial quantity in the fermentation feed according with the fermentation period.

Fermentation period	Decayed bacteria (1gCFU/g feed)		Colibacterial group (MPN/100g feed)		Lactic acid (1g CFU/g feed)	
	EM treatment	CK	EM treatment	CK	EM treatment	CK
Before	4.28 ± 0.60	4.48 ± 0.07	$1.1x10^3$	$1.1x10^3$	3.45 ± 0.06	< 2
2nd day	4.66 ± 0.13	5.69 ± 0.12	$1.2x10^6$	$3x10^8$	5.66 ± 0.10	< 2
4th day	< 2	6.02 ± 0.06	< 3	$4.6x10^8$	8.98 ± 0.05	3.58 ± 0.17
6th day	< 2	5.57 ± 0.13	< 3	$1.3x10^4$	8.73 ± 0.14	5.76 ± 0.24
8th day	< 2	3.49 ± 0.04	< 3	$1.7x10^2$	8.58 ± 0.51	6.61 ± 0.25

EM may soften the dry dung phenomenon, which also proves its regulated function from other aspect, because the diarrhoea and dry dung are two appearances of the maladjustment of the bacterial group so EM also has function of improvement. One third of dung consists of the bacterial body and then the regulation function of EM is rather obvious.

4. EM may stimulate the growth of the immune organs so as to strengthen the immune function and ant disease ability immune function.

Table 5. The influence of EM fermentation feed to the relative weight of immune organ (g/kg body weight)

Group	Treatment	Organ weight/body weight	28 age in days	42 age in days
A B C D Forecast Program	B (CK) B EM10 B EM30	Thymus index	2.71 ± 0.12^b 2.91 ± 0.36^{ab} 2.97 ± 0.45^a Y = 0.763 + 0.008X R = 0.878	1.66 ± 0.39^b 1.78 ± 0.35^{ab} 1.97 ± 0.32^a Y = 1.662 + 0.104X R = 0.998
A B C Forecast Program	B (CK) B EM10 B EM30	Bursa of fabricius index	2.18 ± 0.39^b 2.56 ± 0.49^a 2.60 ± 0.46^a Y = 2.287 + 0.012X R = 0.814	1.49 ± 0.42^b 1.56 ± 0.32^{ab} 1.70 ± 0.37^a Y = 1.492 + 0.007X R = 0.998
A B C Forecast Program	B (CK) B EM10 B EM30	Spleen index	2.17 ± 0.14^b 2.38 ± 0.18^a 2.43 ± 0.31^b Y = 2.222 + 0.008X R = 0.866	1.96 ± 0.37^b 2.15 ± 0.25^{ab} 2.27 ± 0.19^a Y = 1.996 + 0.099X R = 0.944

From the experiments of broiler, Zhang Rijun (1998) found that the relative weight of the broiler immune organ showed the linear relation to the additive amount of the EM fermentation feed, and the relative coefficient was higher than 0.8, which indicated EM was related to the stimulation of the immune organ growth and the content of EM bacteria. The more EM is, the bigger the immune organ.

For example, the broiler thymus index, bursa of fabricius index, and spleen index of the EM that group was obviously higher than that of the CK (Table 5), which also showed that EM could stimulate the growth and development of the immune organs. T cell is the main functional cell for the cell immune response, and B cell is the main functional cell to the humor immune response. The suitable EM level may improve the good growth of the organs, e.g. spleen, etc. and may activate T cell and B cell, so as to display the important function to the immune system.

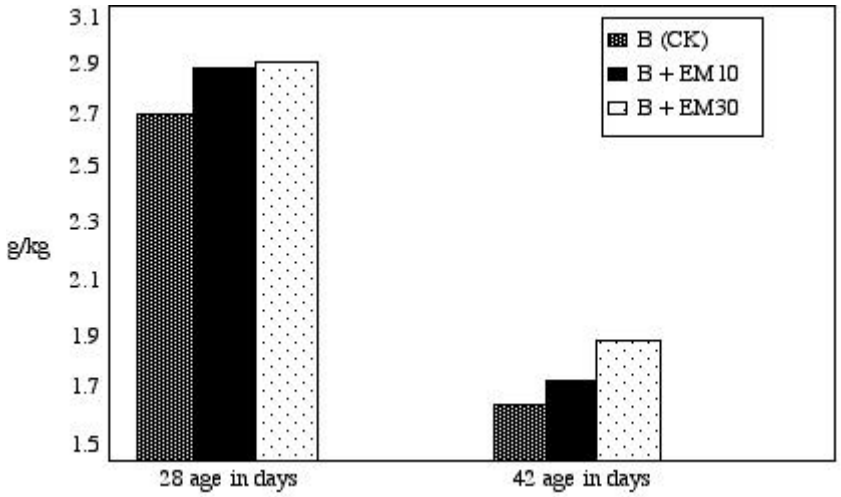

Fig. 2. Relationship of thymus index during different periods and EM add level. (Thymus index)

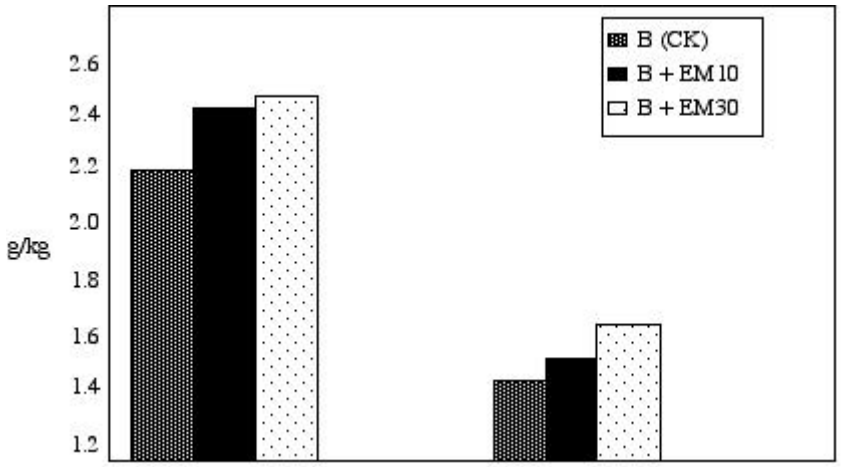

Fig. 3. Relationship of bursa of fabricius index during different periods and EM add level. (Bursa of fabricius index)

The possible mechanism that EM enhances the functions of T cell and B cell may be as follows: EM is a complex of many species of microbes, each of which is a kind of antigen that has the activation function to T cell and B cell, and also increases the effect through the antigen of the macrophage to play the important role to the immune system. In 1989, Fuller reported that to feed with microbes directly may raise the antibody level of animal and poultry, or increase the activation of macrophage to enhance the immune function and stimulate the growth of the living body immune organs of the intestinal tract immune organization, so as to arose the body to grow the humor immunity and cell immunity.

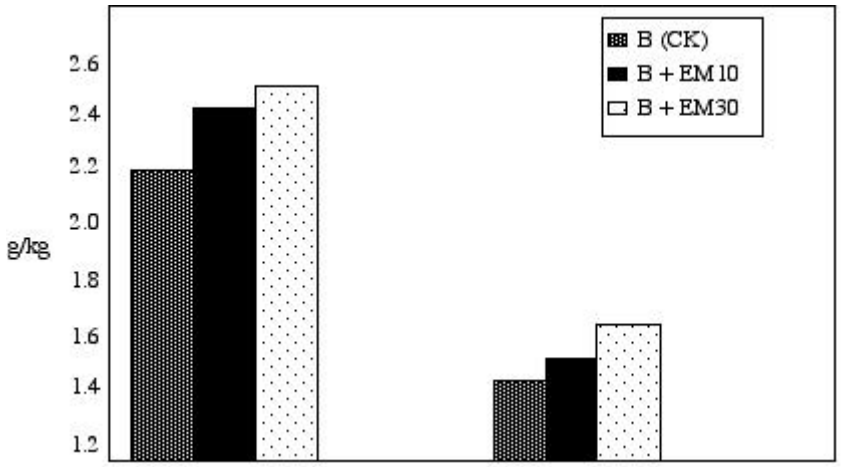

Fig. 4. Relationship between the spleen index during different periods and EM add level. (Spleen index)

5. EM can decrease the release of ammonia so as to have the function of removing the offensive odor.

The bad smell of the animal and poultry farm mainly comes from the animal dung which excretes from the animal body and analyses which the original and outside microbes, enzymes to produce CO_2, H_2S, CH_4, NH_3, N_2O and minor gases (including about one hundred kinds, such as aldehyde, amine, aromatic compound, organic acid, sulfide, etc). These materials pass through three stages, i.e. hydrolysis, acid fermentation and alkali hydrolysis, among which protein and amino acids are the most important factors for the bad smell because the bacterial activities to carry out the decarboxylation and deamination. Their components and characters are very complex.

The dung pH value has direct relation to the release of ammonia. When pH is less than 7, the release of NH_3 is slight; when pH is larger than 8, the release of NH_3 increases quickly. According to Kangbai reported that the main microbes of Gram-negative bacteria, such as *colibacillus*, *denatured bacillus*, *cupreous pseudomonoas*-cellular bacillus, etc. Analyze amino acids to produce NH_3, and some microbes of Gram-positive bacteria, such as *lactic acid bacillus* and *bifibacillus* almost don't analyze amino acids. EM original fluid pH value is 3.5, when it is fermented as above mentioned, its pH value decreases, however, the *colibacillus* is checked and the beneficial bacteria such as *lactic acid bacillus* increase so as to reduce the release of NH_3 and decrease the bad smell.

The above contents are our rough realization about EM functions and mechanism. Due to the limited condition, we can't do many researches but we believe that the more we discover the EM functions and mechanism, the more people will receive EM. EM will devote great contribution to the earth's successive development.