<u>Effective Microorganisms (EM)</u>

Evaluated for Poultry Production and Research

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CONTENTS

INTRODUCTION

This manual was created for people interested in using Effective Microorganisms (EM) for poultry production or research. An attempt has been made to explain what EM is and create a comprehensive evaluation of the theoretical basis for and previous scientific research of EM in poultry production. Because every region and management system is different, a basic experimental design is included in this manual as a guideline for researching the best rates, frequency and methods of application for unique circumstances. Laboratory and field trials have shown very good results when using EM for health, performance, disease control, odor control, and waste treatment in poultry production. The manual also includes general guidelines for the use of EM in poultry production as well as directions for making EM Fermented Feed. EM, like poultry, is a living thing and therefore certain conditions must be met in order to achieve positive results with EM. If you are interested in using EM in poultry production or research, please read this manual carefully in order to understand how EM is used and why it is used so that your production or research will be effective. If EM is used in accordance with the information of this manual many problems of poultry production can be reduced or eliminated.

EM: HISTORICAL, TECHNICAL AND THEORETICAL BACKGROUND

EM stands for "Effective Microorganisms" and was developed by Dr. Teruo Higa of the College of Agriculture at the University of the Ryukyus in Okinawa, Japan. EM is produced and distributed in the United States by EM Technologies, Inc, a non-profit 501(c)3 corporation in Tucson, Arizona. EM is a liquid at a pH of 3.5 that is formed at high pressures by the interaction of a diverse group of naturally occurring, aerobic and facultative anaerobic microorganisms. EM includes high populations of lactic acid bacteria (*Lactobacillus* and *Pedicoccus*) at 1×10^5 CFU/ml suspension, yeast (*Sacharomyces*) at 2×10^6 CFU/ml suspension and fewer amounts of photosynthetic bacteria, actinomyces and other organisms (Guim et al, 1998).

EM has been thoroughly tested and proven safe for human and other animals. The United States Department of Agriculture categorizes all o f the microorganisms in EM as G.R.A.S. (generally recognized as safe). The United States Food and Drug Administration categorizes most of the organisms in EM as food grade microorganisms.

EM was initially developed and used as inoculate for soil conditioning in grain, vegetable and fruit production. As the research and applications of EM developed throughout the 1970's and 1980's EM was found to be an effective tool for manipulating and managing the overall microbial ecology of complex and diverse systems. Microorganisms are in abundance everywhere and have a large influence on biological and chemical qualities such as the extent of putrefaction, fermentation, disease, and oxidation of any system. Prior to the development of EM, the ability to manage these microbial populations on a large scale in an economically viable way did not exist. EM has therefore become a revolutionary tool for managing the dominant microbial populations and increasing the efficiency of most systems.

The world of microorganisms is complex and diverse. Microorganisms are categorized into different kingdoms and yet they are often found to co-exist in a small area The diverse biochemical interactions between multiple species of organisms in infinite numbers of microclimates, makes the academic study, research, and definition of microorganisms difficult. In a laboratory it can take years of study to understand one species of microorganism, Iet alone the interactions between two, three, or four species. With respect to EM, this means that it is very difficult to know exactly what is occurring and why. EM contains microorganisms living in co-existence from several different genera and at least two different kingdoms (microbiologists disagree on the separation of kingdoms). This makes the research and mechanistic understanding of EM extremely difficult. However, EM has been developed during three decades of trial and error in the laboratory and in the field. There are thousands of pages of documentation regarding the function of EM. Unfortunately for most of the world, only about 5% of this documentation exists in a language other than Japanese. However, there is still a large amount of documentation in English and the *in vivo* efficacy and economic viability can not be denied. Therefore it is up to researchers and producers around the world to continue to develop the fundamental theories and understanding of EM so that this valuable tool can benefit the growing human population.

During the mid-1980's, livestock researchers and producers in Japan began to test EM for odor control and waste management. This research continues to the present and has found EM to be effective as a probiotic, waste treatment and biological control agent (Kitazato Environmental Center, 1994). One of the most valuable contributions of EM to the livestock industry is its deodorizing effect within confined facilities for poultry operations. EM eliminates odors by dominating the microbial ecology with organisms that exploit a fermentative pathway and therefore do not produce odorous gases (Yongzhen and Weijiong, 1994).

THE ODOR PROBLEM IN POULTRY PRODUCTION

Odor control is a major problem confronting confined livestock production systems (Ritter, 1981). In poultry facilities some of the odor-causing compounds like ammonia are health hazards for people who work in the facility, for the animals, and are also a nuisance for the surrounding community (Mote, 1984). With the rising costs in both labor and materials, poultry farmers are re-using old litter for as long as four or five flocks. The result of this practice is a significant increase in the levels of ammonia inside and outside the chicken houses (Carlile, 1984).

The formation of ammonia has been attributed to the microbial decomposition of uric acid in the manure (Carlile, 1984). The rate of ammonia volatilization and resulting ammonia concentration in a chicken house depends on factors such as litter moisture content and pH, temperature and wind speed (Moore, *et al*., 1996).

Research on the effects of ammonia on poultry show that it adversely affects growth rates, feed efficiency, egg production, respiratory tract, susceptibility to Newcastle disease, incidence of airsacculitis, levels of *Mycoplasma gallisepticum*, and incidence of

Keratoconjunctivitis (Moore *et al*., 1996). For this reason Deaton and Reece (1980) cited by Carlile (1984) recommend ammonia levels not to exceed 25 ppm. In practice however, the birds are often exposed to levels of over 50 ppm to as high as 200 ppm. Humans detect ammonia levels above 25 ppm and exposure of 100 ppm for eight hours as acute adverse health affects (Carlile, 1984).

Several approaches have been developed in an effort to reduce the levels of ammonia within the facilities. The most common method is ventilation, replacing air from the inside with air from the outside (Mote, 1984). This approach poses a problem to farmers during the winter, when ventilation needs to be reduced to avoid excessive heat loss. The condensation effect, also greater during the winter, generates wet litter that favors ammonia release (Carlile, 1984). In addition, this technique does not reduce the amount of ammonia released to the vicinity and the whole environment. This is an issue to be considered knowing that ammonia plays a key role in the production of acid rain (Moore, *et al*., 1996).

CONVENTIONAL ODOR CONTROL METHODS

Ritter (1981) mentions six categories for odor controlling agents in livestock operations:

- Masking agents: mixtures of aromatic oils that have strong particular odors that can cover up the manure odor.
- Counteractants: mixtures of aromatic oils that neutralize the manure odor.
- Digestive deodorants: bacteria or enzymes that eliminate odors through biochemical digestive processes.
- Adsorbents: products with a large surface area that adsorb the odors before they are re leased to the environment.
- Feed additives: compounds added to feeds to improve the animal's efficiency in nutrient intake and consequently reduce odors.
- Chemical deodorants: these fall into two categories. Those that inhibit microbial decomposition of uric acid and those that combine with ammonia and neutralize it (Moore, *et al*., 1996).

According to Burnett and Dondero (1970) cited by Ritter (1981) masking agents and counteractants were the most effective, followed by chemical deodorants. Digestive deodorants were the least effective.

Carlile, (1984) and Moore *et al*. (1996) mention several effective chemical agents for reducing ammonia production from poultry litter: paraformaldehyde, zeolites, superphosphate and phosphoric acid, acetic and propionic acids, antibiotics, alum and ferrous sulfates. Besides the cost/efficiency problems of these products, some of them can be the source for other problems . Parafomaldehyde is suspected to be carcinogenic (Carlile, 1984), ferrous sulfate can cause iron toxicity in the birds, and the phosphoric acid can increase the phosphorus runoff from fields receiving poultry litter, which is already a current problem facing the industry (Moore *et al*. 1996). Nevertheless, the use of some of these products like zaolites and alum are associated with the increase in egg production, improved animal health (Carlile, 1984) and higher weight gain and feed conversion rate (Moore *et al*., 1996).

EM FOR ODOR CONTROL

There are four different ways in which EM inoculants ("EM Probiotic" and "EM Waste Treatment") can be introduced into the production system in order to achieve a deodorizing effect.

1) As a probiotic additive to drinking water.
2) As a probiotic feed additive.
3) As an additive to sanitation spray water for washing the facility.
4) As a treatment added to the waste handling process.

Considering the 4 methods of application of EM, EM approaches the problem in three of the categories described by Ritters (1981).

- As a digestive deodorant: EM Probiotic is added to drinking water at a dilution ranging from 1:1000 up to 1:10,000 (EM Probiotic: Drinking Water) and can be made available to the animals continually or periodically throughout the growih cycle (Yongzhen and Weijong, 1 994).
- As a feed additive: EM Probiotic can be mixed with a portion ofthe chicken feed, placed in anaerobic conditions, and allowed to ferment for 5 - 10days. The EM fermented feed is mixed with normal feed rations at a ratio of 1 –5% (Yongzhen and Weijong, 1994). If the fermented feed cannot be easily fermented EM Probiotic can be lightly sprayed over the feed at a ratio of 1 : 100 (Kitazato Environmental Center, 1994).
- Non-chemical deodorant : EM Waste Treatment is used as a disinfectant to regularly spray the facility and to inoculate the litter (once a week is usually enough) with beneficial microorganisms (Philips, 1997).

EM Probiotic helps balance the microflora within the animal's digestive tract and according to Yongzhen and Weijiojng (1994) EM increases the coefficient of nitrogen utilized by the bird. At the same time the wastes generated by the broiler or laying hen receiving EM Probiotic will tend to begin fermenting while they are being produced. This represents a big advantage for the future management of the manure because it will be populated with fermentative microorganisms rather than putrefactive and pathogenic ones (Philips, 1997). With this same purpose, EM Waste Treatment is applied to wash down the facilities and to inoculate the litter with Effective Microorganisms. The photosynthetic bacteria in EM are able to separate the hydrogen in ammonia, in hydrogen sulfide and in hydrocarbons; it deoxidizes carbon gases and synthesizes sugars. The lactic acid bacteria in EM produces lactic acid that kills pathogenic microorganism. Yeasts in EM form alcohol and various organic acids (Higa, unknown date).

Ammonia is the largest contributor to foul odors being emitted from poultry facilities. Experiments done by Yongzhen and Weijiong (1994), with groups of 400 to 500 broilers and laying hens, indicate that the use of Probiotic EM in the drinking water reduced the ammonia concentrations within the chicken houses by 42.12%. The use EM fermented feed reduced ammonia concentrations by 54.25% and the combination of the two techniques reduced ammonia concentrations by 69.7%.

A case study with 30,000 adult and 20,000 young Mary and Borisbrown chickens took place in the Gifu Prefecture, Japan. This study showed very good deodorization effects in the chicken dung. The ammonia concentration in the chicken dung not treated with EM was 256 ppm, while the concentration in the birds that received 1% of fermented feed was reduced to 36 ppm. This effect made unnecessary an afterburner that was previously, used to control the foul odor of the chicken dung (Kitazato Environmental Center, 1994).

Another case study reported from the Aichi Prefecture, Japan on a farm of 150,000 laying hens showed a significant reduction in the foul odor of the poultry houses and the dung. EM was mixed in the drinking water, it was used to ferment 1%-2% of the feed and it was also sprayed throughout the inside of the poultry houses once a week. The ammonia concentration in the chicken houses was reduced from 4.4 ppm to 3.9 ppm after the introduction of EM in the system. It must be mentioned that the data obtained previous to the use of EM was taken with the doors open, and the data obtained after using EM was taken with the doors closed (Kitazato Environmental Center, 1 994).

EM's deodorizing effect has also been demonstrated in the urban waste management field. In Naha City, Japan, EM Waste Treatment was introduced in the standard activated sludge management plant, adding one liter of EM to each ton of raw sewage. EM Waste Treatment was added before the sewage entered the aeration tank. In terms of odor, Hydrogen Sulfide and Methyl mercaptan were analyzed before and after EM treatment.

Table 1. Hydrogen sulfide and methyl mercaptan concentrations in the Sewage Management Plant of Naha City, Japan.

	Ppm	
	Before EM Treatment	After EM Treatment
Hydrogen Sulfide	11.8	0.78
Methyl Marcaptan	0.075	0.0071

(Higa, 1995)

DISEASE PREVENTION IN POULTRY PRODUCTION

The poultry industry has become the most intensive of all the branches of livestock production. Both eggs and chicken meat are now generally produced in units of 100,000 birds or more, requiring good planning and subsequent management (Sainsbury, 1992). Due to the degree of the confinement, the breakout of a disease can represent the loss of many animals. Therefore great enphasis must be made in the prevention of diseases (Sainsbury, 1992). Some of the basic steps concerning the prevention of chicken diseases are:

- Control of the environmental conditions: appropriate air movement, ventilation, temperature and moisture levels.
- Vaccination: some respiratory infections like Newcastle disease can be effectively controlled through vaccination.

- Disinfecting of buildings: disinfecting has the purpose of providing the birds with an environment free of pathogenic agents such as, bacteria, fungus, virus, and parasites.
- Appropriate litter management: if inappropriately managed, the litter can become a source of inoculate of pathogenic microorganisms (Sainsbury, 1992).

EM FOR DISEASE PREVENTION

EM Waste Treatment used as a spray to wash down the facilities acts as a disinfectant of the building. In a study done in the Aichi Prefecture, Japan, after one year of the introduction of EM in the production system, it became totally unnecessary to use antibiotics and disinfectants for the 150,000 laying hens. Almost all of the vaccines that had been used were no longer necessary as a result of the overall improvement of the bird health (Kitazato Environmental Science Center, 1994).

Disinfectants used are generally chemical products such as phenol compounds or formaldehyde, although the latter has been prohibited in some countries because it can be hazardous to the health of humans. These products are usually applied when a flock is harvested and the building is empty (Sainsbury, 1992). Because of the nature of the product, EM Waste Treatment can be used to spray down the building even when the birds are in it.

A farm in Texas that raises approximately 500,000 broiler chickens per year decided to integrate EM in to the regular chicken house cleaning. EM was sprayed over the walls and ceilings and was also applied to the bedding. In terms of health improvement, after one growing period (46-49 days) the average rate of mortality decreased from 6.4% without EM treatment to 2.9% with EM treatment.

EM Waste Treatment is also used to appropriately manage the litter. The reduction of ammonia levels and the inoculation of the litter with beneficial microorganisms that compete for nutrients against pathogenic ones is the second approach to prevent the proliferation of disease causing microbes. Carlile (1984) and Moore *et al*. (1996) also reported health and performance improvement through the reduction of ammonia levels using paraformaldehyde and alum respectively.

The third approach for health improvement using EM is related to the use of EM Probiotic as an additive to drinking water and feed. The gastro-intestinal tract of birds may house several pathogenic microorganisms (Larbier and Leclercq, 1994). The consumption of EM by the animals is expected to result in health improvements apparently because of competition with pathogenic microflora in the digestive tract.

Anjum *et al*., (1996) reported greater bursa and thymus index in commercial broiler chicken supplemented with EM through drinking water and fermented feed. According to this study EM supported these two important lymphoid organs that make up the vital components of humoral and cellular immunity. Antibody geometric mean titre (GMT) against Newcastle disease vaccine virus was 6.5 times in broilers given EM in drinking water, 3.85 times in broilers given EM fermented feed and 3.73 times in broilers given both EM in drinking water and fermented feed. At the same time, the EM treated birds which had an increase in live body weight compared to the non treated birds, presented a decrease in the following measurements: offal weight, liver index, gizzard index, intestinal weight index, intestinal length index, kidneys index, and heart index. This indicates that EM can work as a growth promoter without any associated risks.

EM FOR CONTROL OF PATHOGENIC MICROORGANISMS

Poultry products have been blamed for the transmission of *Salmonella spp* and other human diseases (Stern, 1994). *Salmonella enteritidis* is the most reported strain causing human infection and there has been clear epidemiological association of these cases with the consumption of eggs and poultry meat (Sainsbury, 1992).

According to Edens *et al*. (1997) the colonization of lactic acid bacteria in the chickens intestinal tract apparently controls the population of pathogenic microorganisms such as *Salmonella spp*., *Enterococci* and *E. Coli*. Lactic acid bacteria produce significant amounts of bacterial growth inhibitory substances such as reuterin. Reuterin has a broad-spectrum antimicrobial activity that has proven to inhibit the growth of bacteria, fungi and protozoa.

EM contains selected species of microorganisms that include predominant populations of lactic acid bacteria (Higa and Parr, 1994). The information about the effect of lactic acid bacteria over these pathogens, suggests a possible positive response to thc use of EM Probiotic.

Another fact that suggests the possible effectiveness of EM against these types of pathogenic microorganisms is related to the results obtained in several studies in urban waste management. The experience in Naha City, Japan shows significant reduction in *E. coli* populations after the introduction of EM in the system.

Table 2. E. coli populations before and after EM Treatment in the Sewage Management Plant in Naha City, Japan.

	Part/ml	
	Before EM Treatment	After EM Treatment
E. coli	12000	1900

(Higa, 1995)

According to Higa (1995), 30 days after treating the waste water in the Gushigawa City Library, (Okinawa) with EM, *E. coli* levels were undetectable, dropping from 8500 parts/ml to 0 parts/ml. EM Waste Treatment was used in a solution of 1 : 1000 EM/waste water. The EM solution was flushed down the toilets.

BIRD PERFORMANCE IMPROVEMENT WITH EM

The improvement in poultry performance due to the use of EM can be a consequence of having healthier birds living in a healthier environment. This is the experience of the farm in Texas, where some performance improvement has been achieved after the regular use of EM Waste Treatment to wash down the facilities. The average weight of the flock has increased and as a consequence, the percentage of chickens not meeting the market specifications for shipment has been reduced. Apparently the healthier environmental conditions created due to the applications of EM are responsible for these improvements (King, 1998).

Another explanation for the improvement of the animal’s performance after the use of EM can be related to the inoculation of the gastro-intestinal tract with beneficial microorganisms. The gastro-intestinal tract of birds is host to approximately 40 species of microorganisms with 3 or more different types of each one. The flora plays an important role in the digestion process. Bacterial enzymes promote the digestion of protein, Iipids and carbohydrates and bacteria also synthesize vitamins that contribute to the nutrition of the bird (Larbier and Leclercq, 1994). According to Yongzhen and Weijiong (1994) EM Probiotic improves the coefflcient of nitrogen absorption in the animal. After 45 days of EM treatment in day-old commercial broilers; live body weight was approximately 2004 grams for broilers given EM in drinking water, approximately 1978 grams for broilers given EM fermented feed and approximately 2022 grams for broilers given EM in both ways, compared to approximately 1690 g of the control broilers.

Yongzhen and Weijiong (1994) also found that the concentration of aminoacids in the feed was improved 28% after the fermentation process with EM, indicating that EM improves the quality of the feed. A study that took place in the Aichi Prefecture in Japan with 70,000-80,000 Arbor Acre broilers using EM for two years, shows an improvement in the feed conversion rate and an increase in the weight increase per day. The average broiler weight at shipment went from 2.68 Kg to 2.9 Kg. EM was given in the drinking water once a week and it was also sprayed inside and outside the chicken house before the birds were brought in (Kitazato Environmental Science Center, 1 994).

Regarding egg quality, a study done in the Gifu Prefecture, Japan, with 30,000 adult and 20,000 young Mary and Borisbrown chickens shows the effect of working with EM for two years. EM was given to the birds as EM fermented feed at 1% rate. The EM treated group had higher values than the non treated group in the following categories: average egg weight, eggshell strength, eggshell thickness, albumen height, Haugh units and yolk color. In this same farm, the chicken excreta is being sprayed with EM to create a fermented compost that has a good reputation as being effective in increasing crop yields (Kitazato Environmental Science Center, 1 994).

POULTRY LITTER MANAGEMENT WITII EM WASTE TREATMENT

Another of the positive effects that EM has in the general management of poultry facilities is related to the quality of the organic fertilizer produced with the manure. Poultry manure is a very useful resource for the production of organic fertilizers. Hussain *et al*. (1994) found that the nitrogen content of poultry manure increased after composting with EM.

Effect of EM on the Nitrogen Content of Organic Materials Initially and After 15 and 45 days of Composting with and without EM.

Organic Material	Nitrogen Content (%)				
	Initially	After 15 Days		After 45 Days	
	No EM	No EM	EM	No EM	EM
Farmyard manure	0.42	0.49	0.70	0.70	0.84
Poultry manure	**0.56**	**0.84**	**1.19**	**0.98**	**1.26**
Wheat straw	0.35	0.42	0.49	0.49	0.56
Rice straw	0.28	0.28	0.35	0.42	0.49
City Waste	0.35	0.49	0.56	0.56	0.63

(Hussain *et al.*, 1994)

According to Hussein *et al.* (1994) the amount the time needed to obtain compost was significantly reduced after the inoculation of the piles with EM.

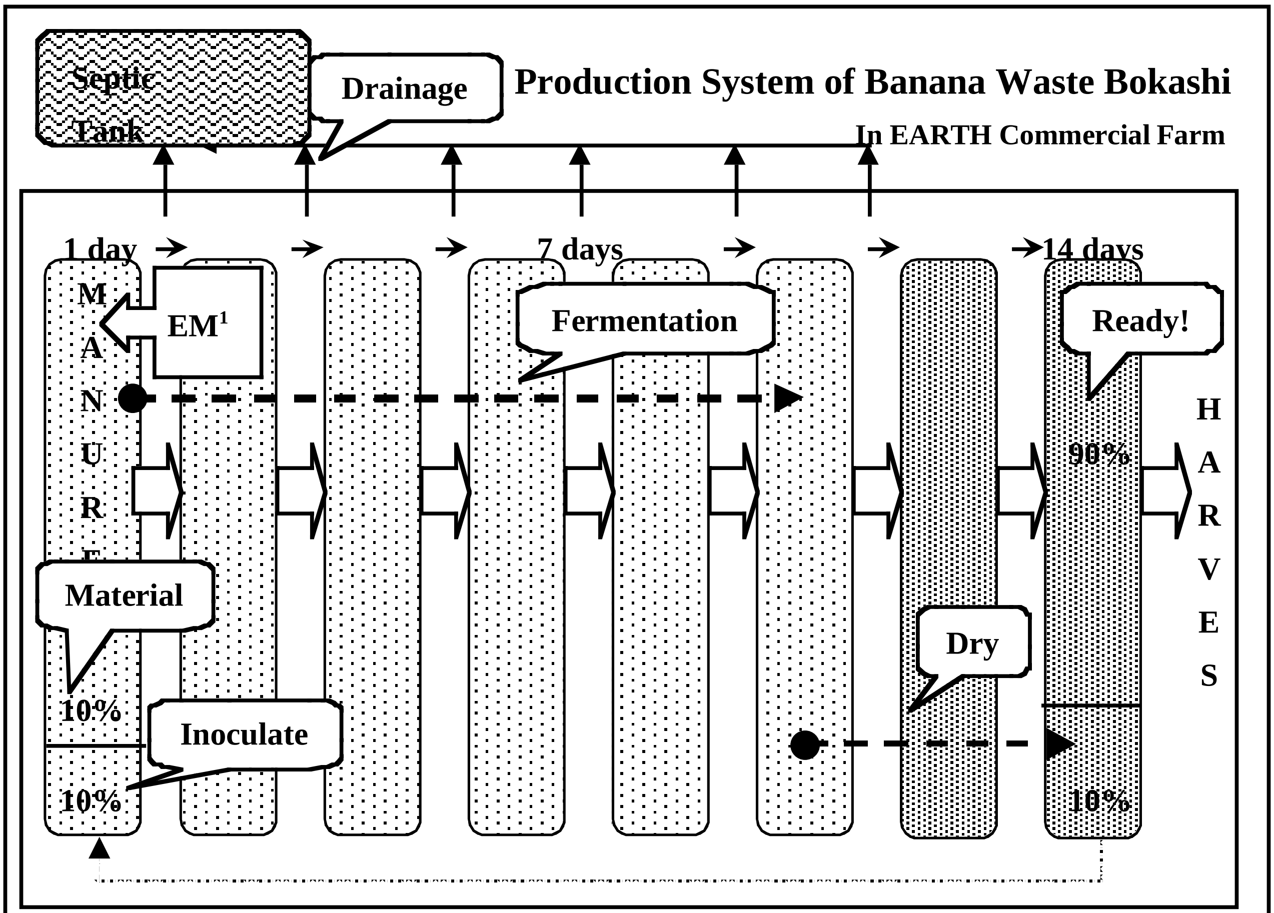
Using EM, solid wastes from the poultry industry can be processed alone or mixed with other easily obtained organic materials. Other materials used can include legumes, rejected seed yams, fish meal, corn meal, rice husks, sawdust, carbon and ash. The materials are chopped, mixed well, and inoculated.

To prepare EM for inoculating the materials, molasses is dissolved in water and EM is added to this solution. There is a final ratio of one part EM to one part molasses to 100 parts water. This solution is sprayed on the materials to achieve a final moisture content of 30-40%.

The following guidelines for making bokashi with solid waste from the poultry industry are the results of two years of field study undertaken at EARTH College in Limon, Costa Rica and the Mokichi Okada Research Center in Ipeuna, Sao Paulo, Brazil. Processing solid waste into bokashi should take place under shelter that will protect the materials from direct sunlight and precipitation (see diagram on next page).

The more surface area of the materials available to the microorganisms, the quicker they will populate a larger percentage o f the materials. Therefore it is important to devise some way of chopping the materials. The chopping method used will depend on the type and quantity of waste processed. However, with poultry litter alone, chopping is not necessary because of the relatively small sizes of the litter.

It is very important that the materials have the correct moisture content for the fermentation process that takes place. The best moisture content is 30-40%. If the water content is controlled there are fewer insects attracted, less foul odors, and a quicker population of the materials with beneficial soil microorganisms.



- Turn over the materials every day by tiller machine.
- In this system bokashi will be ready in 2 weeks.
- [1] Apply activated EM. (EM:molasses:water = 1:1:100)

When materials are in small pieces, mixed well, have a good moisture content and a good microbial inoculate like EM, a good bokashi is obtained. A good bokashi always has a sweet fermented smell and is covered with white mycelia. These indicators signify that the materials are populated with beneficial microorganisms.

For making bokashi that is semi-aerobic (not completely sealed) it is important to maintain the temperature at around 50 degrees Celsius. This is because when the temperature is too high there is a loss of heat energy, production of butyric acid, and production of other putrefactive substances (Phillips, 1995). High temperatures can be avoided by turning the bokashi the day after making it.

When the guidelines outlined above are followed, a good bokashi is obtained as signified by the sweet fermented smell and the white mycelia. Foul odors and insect pests disappear within 48 hours and within two weeks the process is complete.

HOW TO MAKE EM FERMENTED FEED

The process for making EM Fermented Feed is simple. Inoculate the poultry ration with EM, mix well, and then ferment the ration under anaerobic conditions for 48 hours. When this process is complete, the EM Fermented Feed is ready for incorporation into the bird's ration at the recommended ratio. Guim et al found that the greatest bird performance is achieved when EM Fermented Feed is 4% of the ration during the first 15 days of the chick's life, then 20% of the ration for the remainder of the birds life.

Here are the quantities of materials to make 4% EM Fermented Feed for a ration of 100kg:

1) 4kg of ration (taken from 100kg to equal 4% of the total).
2) 1,200mL of EM-molasses solution which consists of the following (this gives approximately 30% moisture content) :
    A) 48mL of EM (4% of total solution)
    B) 36mL of molasses (3% of total solution)
    C) 1,116mL of water

After making the fermented feed it can remain viab le when kept under sealed conditions for approximately two weeks or dried and kept under sealed conditions for approximately 2 months.

TESTING EM: RECOMMENDED EXPERIMENTAL DESIGN

Research is recommended to be conducted with one day old broiler chicks because this allows the establishment of beneficial microbial populations within the digestive system from the beginning. Establishing the beneficial microbial populations will allow the greatest control of pathogenic species of organisms. The first three weeks of the bird's life is also the most crucial in terms of future development and performance (Guim et al, l998).

The management of feed should be divided. into four phases: 1 to 14 days, initial ration; 15 to 28 days, growth ration; 30 to 41 days, maintenance ration and 42-45 days, fattening ration.

Guim et al (1998) has determined that there is significant increase in bird performance when EM Fermented Feed is added to the ration at 4% during the first two weeks. Therefore, in order to further refine the optimum EM application techniques, the following treatments are recommended:

1) Control 1 (4% of feed is subject to the same process of fermentation without the addition of EM and fed to the bird during mixed with the ration for the entire life).
2) Control 2 (Regular ration without any Fermented Feed)
3) 4% EM Fermented Feed with ration during the entire life.
4) 4% EM Fermented Feed during the first 14 days, then 2% EM Fermented Feed during the remainder of life.
5) 2% EM Fermented Feed during the entire life.
6) EM in drinking water at a dilution rate of 1 : 5,000.
7) EM in drinking water at a dilution rate of 1 : 1,000.

For statistical analysis, there should be a total of 6 replications of each treatment. Each replication can have 5 birds, for a total of 30 birds per treatment.

The performance of the birds will be evaluated by analyzing feed conversion rates, feed intakes, and body weight gains. Ammonia is one of the main gases that generate the foul odors surrounding poultry facilities. EM has been proven to reduce ammonia emissions. This study should try to determine how EM reduces ammonia emissions. Nitrogen digestibility should be measured to determine if EM causes more nitrogen to be utilized by the bird. If more nitrogen is used, there is less nitrogen in the excreta for volatilization, thus reducing ammonia emissions. Nitrogen digestibility will be measured by adding chromium to the feed. Nitrogen volatilization will also be measured by incubating samples of excreta and determining nitrogen content at 0, 12, 24, and 48 hours of incubation. With this method, it can be determined if EM effects the volatilization of nitrogen from the excreta.

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