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Agricultural Organic Waste Composting from sugar factory waste and Its Application

By

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1. What is composting?

Biological residue and animal excrement, sometimes combined with a small amount of ore or chemical fertilizer, are blended with the proper carbon-to-nitrogen ratio, moisture content, and aeration in a pile. After a period of piling and turning over, the decomposed product from microbial fermentation is called compost (organic fertilizer).

2. The benefits of composting

2-1) Improper disposal, buried, or incineration of biomass (organic wastes) can cause environmental pollution, destroy the ecosystems, and endanger human health.

2-2) Organic wastes such as household food scraps and agricultural biomass can be converted into useful organic fertilizers, reducing the environmental management challenge of waste disposal.

2-3) Organic waste compost is the product of decomposed biomass. By constantly turning over the piled-up biomass, organic matters in the biomass can be decomposed by microorganisms, transforming the organic matter to soft, brown organic fertilizer with an earthy aroma. Compost can be directly applied to soil to help in crop growth.

2-4) Applying compost as an organic fertilizer is the healthiest and the most environmentally friendly way for farming. It can improve and activate the physical, chemical, and biological properties of soil by supplying crops with substantial nutrition, providing them a good growing environment. Doing so can enhance quality of the resulting agricultural products.

2-5) Composting can make agricultural biomass that contain rigid fiber such as tree branches, soft and spreadable as well as turning odor of certain plants to smell earthy.

2-6) Compost can help in reducing the dependence of chemical fertilizer, thereby creating a healthy, safe, and comfortable living environment.

3. Agricultural biomass suitable for composting

Agricultural biomass can be divided into two main categories based on their carbon to nitrogen ratio (C/N ratio):

Class A: High carbon to nitrogen ratio. For example, woodchip, chaff, straw, corn stalk, and peanut hull. These materials provide the major carbon source for composting, which determine the physical properties of a compost.

Class B: Low carbon to nitrogen ratio. For example, chicken manure, pig manure, cow manure, soybean meal, rice bran, meat, and bone. These materials provide the necessary nitrogen sources for composting, by improving microbial growth and reproduction. Besides, they can also be applied directly in the farm without being composted.

4. Composting conditions

4-1) Moisture:

a. The ideal moisture content for composting is 60%.

b. Low moisture content can slow down the reproduction of microorganisms, hence slowing down the temperature elevation, which can lead to longer fermentation time and lower decomposition rate, resulting in incomplete composting.

c. Excessive moisture and insufficient oxygen supply can turn the fermentation reaction from aerobic to anaerobic. This can cause a lower temperature elevation in the biomass pile, lowering the rate of decomposition, prolonging the fermentation time, in addition to forming unpleasant odor. Materials such as woodchip and rice husk can be added in the early stage of composting to counter the high moisture problem.

4-2) Air:

a. If oxygen supply is sufficient during the fermentation process, the aerobic and semi-anaerobic microorganisms can perform aerobic metabolic process effectively, thus, preventing the formation of unpleasant smell.

b. If the supply of oxygen is lacking, the growth of aerobic microorganisms will be inhibited, while anaerobic and semi-anaerobic microorganisms will be active. Therefore, anaerobic decomposition with low metabolic efficiency is likely to dominate the decomposition reaction. Also, a strong unpleasant odor will be produced as a byproduct of the reaction.

4-3) Temperature:

a. After the piling is completed, elevation of the pile temperature will occur. When it reaches 60 to 75°C, seeds of weeds and pathogens will be killed. The optimum

temperature for fermentation is between 40 and 60°C, beyond that, the decomposition by thermophilic microorganisms will be dominated, slowing down the composting process. Therefore, when the temperature exceeds 60°C, the pile must be turned over immediately to ensure even mixing of the internal and external materials.

b. After turning over the pile, air circulation can be improved and the pile can be cooled down, before the internal temperature rise again. When it exceeds 60°C, the pile must be turned over again immediately. After several times of turning over, typically in about two to six months' time, depending on the biomass material, carbon to nitrogen ratio, and the composting condition, physical appearance and texture of the original biomass will change, and an earthy aroma will be produced.

4-4) Fermentation strains:

There are many microbial populations present in the natural environment. By simply adjusting the environmental conditions, these microbial can be utilized for composting. Therefore, it is not necessary to add in any specific microbial strains, though, if appropriate microbial strains are added, the time for composting can be shortened. However, if a large number of non-decomposable substances are present in the biomass, specific microbial strains can be added to shorten the composting time.

4-5) Biomass pretreatment:

Biomass used for composting should be in small pieces. Hence, biomass such as fruit tree branches, large leaves, or corn stalks need to be pulverized into smaller pieces before being composted.

5. Composting of biomass (organic waste)

5-1) Composting preparation: Mix the biomass evenly and adjust the moisture content to about 60% (estimate by grasping the well-mixed biomass in hand, water should seem like it will start to drip), then stack the biomass up to about 1.5 to 2 meters (less than 3 meters), preferably in a pile with a shape of long strip. If Class A material is used (high carbon to nitrogen ratio), the pile temperature will elevate slower and the fermentation time will be longer. Materials such as chicken manure or soybean meal can be added to the pile to increase the nitrogen content, to help in speeding up the composting process.

5-2) Thermometer insertion and signboard setting: Temperature should be determined using a thermometer that is inserted at a depth of about 60 cm in the pile. Every pile should have a signboard for documentation purpose. Record the date of turn over, temperature, moisture content, and pH value.

5-3) Turn over: Check the pile temperature every day and turn it over immediately when the temperature is in the range of 55 to 60°C (Avoid leaving the pile in high heat for long hours).

5-4) Composting completion: After several times of turning over, the elevation of temperature will slow down. The appearance and texture of the raw materials will turn brownish with a hint of earthy aroma, indicating the completion of composting (at this

time, the pH should be close to neutral and the carbon to nitrogen ratio should be within the range of 20 to 25).

6. Examine the completeness of composting

6-1) Temperature: By composting under moisture content of 60%, composting temperature can elevate to about 60 to 75°C in the beginning, then gradually decrease until near room temperature after the completion of composting.

6-2) pH: Unless the biomass used contain extreme acidic or alkaline materials, otherwise it is generally not required to control the pH. A compost is typically neutral, i.e. pH 7.0.

6-3) Odor: Absence of malodor is an indication of complete composting.

6-4) Smell: Earthy aromatic.

6-5) Color: Brownish.

7. Comparison of desired and undesired characteristics of organic composting

Subject	Desired	Undesired	Remark
Composting status	Complete composting	Incomplete composting	
Microbial	Aerobe	Anaerobe	
Decomposition	Oxidation	Reduction	
Gas production	Carbon dioxide	Methane and ammonia	
Weed seeds	No germination	Sprout	
pH	Mild acidic or neutral	Acidic or alkaline	
Temperature	Gently elevated	Cold or warm	
Smell	Aromatic	Malodor, sour	
Color	Brownish	Black	

8. **Application of compost**

8-1) The stabilized organic materials after composting (compost) can be used directly in farms as an organic fertilizer. The difference between an organic fertilizer and a chemical fertilizer is that a chemical fertilizer is chemically synthesized. It is quick-acting but not long-lasting. Also, long term application can affect the soil activity and cause soil acidification, which can lead to decrease in crop yield. An organic fertilizer is a natural product that is slow-release but long-lasting. Opting for organic fertilizer can help in avoiding salt damage and acidification in soil. Besides, it can also restore the vitality of soil and enhance soil activity by increasing organic matters in soil, ultimately improving crop growth (more leafy tree branches, darker green leaves, sweeter fruits).

8-2) The completeness of composting and the fertilizing efficiency are directly related. If composting is complete, the resulted compost (some of which has turned into soil) is completely safe to be used to fertilize crops; if, however, composting is incomplete, the compost should be mixed with soil and avoid being used in farms. Even though using this compost will not harm the crops, it can compete with the crops for nitrogen source in soil.

Example

Taiwan Sugar Tianbao No. 11 Organic Fertilizer

Weight: 20 kg

Specification: 1% total nitrogen, 0.3% water-soluble phosphorus, 2% water-soluble potassium oxide, 60% (or more) organic matter, 40% (or less) moisture content, citric acid-soluble magnesium oxide, hydrochloric acid-soluble calcium oxide.

Ingredients: Concentrated fermented molasses, sugarcane bagasse.

Product Features:

1. Fertilizer that is uniformly fermented, long-lasting, and has stable quality.

2. Environmental friendly fertilizer that is strictly plant based, odorless, does not contain disease vector, and will not cause environmental pollution.

3. Improve physical properties of soil, promote pellet formation, and increase permeability.

4. Regulate the release of nutrients and promote the reproduction of beneficial microorganisms in soil.

5. Restore soil activity by replenishing nutrients and trace elements.

Use: As an organic fertilizer for various crops.

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