Mushroom compost– the basics and issues

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Poland has a leading position in producing and exporting mushrooms in the fresh market in Europe mainly due to the fact that the compost is produced here in this country. The production technology is based on experience from the Netherlands. In Poland the main mushroom cropping is done on shelves with phase 3 compost and harvesting is carried out selectively. It allows us to achieve good crops on the average level of 32kg/m2 in a year. The mushrooms are produced in the phase 2 and 3 compost in blocks covered with film.

Since 1994 there has been a rapid growth in phase 2 compost production in pasteurisation tunnels – initially in phase 1 compost stacks and produced seasonally using traditional methods. Due to large investments in pasteurisation tunnels and steady and rising growth of demand, changes in phase 1 compost production were needed. The compost had to be produced from quality materials that were easily available. The phase 1 compost production was developing based on individual concepts and technical solutions using the general trend for phase 1 production in bunkers with aerated floors. That was due to the necessity to solve the following issues:

1. The compost production based on straw and varied poultry manure – from broiler with straw to cage manure from laying hens – in case there is no horse manure.
2. The compost production in winter season when the air temperature drops to

-25°C or below for a few consecutive weeks, which does not allow production using traditional methods using small piles and initial soaking due to freezing of small and large piles when pouring on liquid manure.

1. Solutions need to be developed in regards to the environment protection to fight the ammonia and odour emissions in ever growing compost production facilities.

The challenges require a special approach towards phase 1 compost which involve mixing all the raw materials in day 0 and raising the level of moisture to the maximum and introducing the manure and gypsum solution into the inner straw structures. Next, after the surplus manure and gypsum solution leaches out, the compost was placed for 1 day on the aerated floors or bunkers or only in bunkers with aerated flooring. The next stages of production took place there, e.g. opening and defiberising of straw, ammonification, water incorporation and caramelisation. This method has been described by an author of the publication *Compost production in mushroom cultivation* (PWRiL, 2007) who was a consultant for Polish compost production plants in the time when the technology came about and was implemented.

The interest around the compost production in Poland was especially vivid for the Dutch consultants in 2004 when the phase 3 compost production became more dominant.

The development of the compost production is also worth considering. An independent approach to produce the compost and the exchange of opinions and information with the Dutch specialists as well as the challenges to face with ever expensive compost production allow us to make general assumptions, which make the fundamentals of the technologies we use today:

1. The compost and mushroom production is carried out using the composting process in the conditions where the oxygen (air) is accessible at all times.
2. The composting process has two phases: hot and cold.
3. The hot phase of the composting process – it’s a production technology of the phase 1 and 2 compost. In the process many groups of microorganisms are developed through a controlled method depending on the change of temperature, access to water, nitrogen, microelements, polysaccharides and oxygen.
4. Phase 1 compost production technology – it’s a preparation of the raw material for the compost microbiological treatment during the phase 2 production. The raw material is treated during the following stages:
5. Straw hydration: the process begins when the straw moisture exceeds 30%;
6. Straw dewaxing and defiberising during controlled growth of microflora (microbiological treatment) at low temperatures, mesophilic phase;
7. ammonification: nitrogen transformation, water absorption during the process controlled by higher temperatures, thermophilic phase;

The condition to be met for the correct flow of the thermophilic and mesophilic phase is to provide a higher moisture content in the compost than its temperature;

d) caramelisation, sugar transformation at high temperatures of 75-85 ° C.

1. The basis for the production of phase 2 compost is the maturation process providing selective food and development environment.
2. The sanitizing process takes place during the hot phase. It is not only the process of pasteurization, but also a mesophilic phase – the conditions with low temperatures (chlamydospores come to life) and nitrogen transformations, and also a thermophilic phase of high temperatures.
3. During the cold phase of composting mushrooms colonize the compost and coat - vegetative stage - and after the change of living conditions the mushrooms are in the fruiting period - the generative phase.

What are the consequences of accepting the given assumptions?

1. The terms "fermentation" and "initial hydration" are incorrect. Whenever the straw moisture exceeds 30% and the smallest nitrogen amounts get in the straw (horse manure, manure, nitrogen fertilizers) the process of composting is initiated, and thus the production of the base, regardless of where it takes place: in the composting plant, or in the stable. This process can be controlled to some degree.
2. The basic conditions that must be met in order for the process to work correctly:

a) the C: N ratio in the ammonification phase must be met and it is 25-30 : 1, then over the course of composting the ratio C : N falls down. The C: N ratio is an indicator of the process and the depletion of the compost as a source of mushroom components after its colonization;

b) water available at all times (in the case of meso-phase and thermophilic moisture is higher than the temperature);

c) oxygen conditions must be met. Lack of oxygen starts the process of digestion, which eliminates the presence of the mushrooms in the environment;

d) the compost surface must be even and it’s achieved by the mixing it during the production or keeping the temperature on the same level in the room.

e) the required temperatures in different stages of production must be kept without the oxygen (air) excess or deprivation.

1. The results of a hot stage are:

a) the binding of ammonia in the maturation process, providing the possibility of mushroom colonization in the compost;

b) obtaining food compost containing carbohydrates, humus-lignin complex and protein derived from dead thermophilic organisms;

c) obtaining the largest possible mycelium contact area with the compost(straw defibering);

d) structure providing gas exchange in the cultivation process.

What are the remaining questions to answer about phase 1?

1. What the C: N ratio is the most appropriate when starting, as the composting process takes place within such wide limits? If it does not matter, this means that the dosage of raw materials need not be so strict.
2. How long should the different phases of the phase 1 compost production last? Normally the compost production using straw and manure is 14 days long. Can it really be shortened in any conditions to 7-10 days? How do you count the length of the compost production using horse manure and later used “indoor”?
3. How to measure, for example, the degree of fibration and ammonification process? Is the indicator of the ratio NH4+ : -NO3- correct?

What are the remaining questions to answer about phase 2?

The main problem is to determine the compost parameters which should be measured in order to fully assess its value as a result of composting.

This issue is all the more interesting that the assessment of the compost through yielding is unreliable. This is due to the wide range of crops harvested from the same batch of compost. This phenomenon is particularly evident in the mushroom satellite growing system in Poland. In turn, the crop growing in a closed cycle, in the independent production, the size of yield depends on the skills of the technologist in charge of the cultivation. It is often observed that the yields are stable and dependent to a small degree on the compost type or the volatility has nothing to do with the compost type.

In this situation, the question arises, what affects the quality of the compost objectively? Is it the technology used, available resources, climate variability? Is it possible to make changes to the technology to reduce costs, for example, reduce the composting time, reduce the number of phases, airing time in tunnels, etc., as it is impossible to quickly and reliably estimate the compost productivity.

From the point of view of the compost productivity we are interested in the content of basic components, such as carbohydrates, humus complex and dead micro-organisms after the hot phase of composting as a source of protein. You may want to focus on the measurement, for example, to determine the amount of carbohydrates in organic matter. In the ligno-humic complex you can use the method to determine humus acids, humic and fulvic acids. However, to determine the levels of dead microorganisms you can use the method to determine crude and digestible protein. This will allow you to determine the nutrition and feeding needs of the mushrooms and the amount of compost that should be used to obtain a high degree of its efficiency.

It is also good to analyse the scientific research and its results carried out in accordance with the environment protection rules in regards to the technology and process of composting.

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