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Composting Daily Poultry Mortality: "Under the Hood"

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Intro

This article will provide a basic "under the hood" understanding of how mortality composting works. Composting can be a safe and effective way to dispose of and utilize normal unavoidable livestock and poultry mortality. To successfully conduct mortality composting appropriate equipment and structures need to be installed and required daily management practices must be followed. A basic understanding of the underlying principles will help to properly and effectively complete daily management practices. The potential consequences of poor management of mortality compost are ineffective or incomplete pasteurization of diseases, problems with vectors such as flies and scavengers, excessive and objectionable odors, water quality concerns, neighbor complaints, as well as regulatory and legal problems. With good management these potential problems are avoided or minimized and the resulting compost material can be uses as a beneficial soil amendment.

Whether composting takes place in a traditional bin, windrows, or a new rotary drum unit, composting is based on a natural process where various microorganisms ultimately decompose the initial mixture into a high organic content soil-like material. However, with mortality composting the typical goal is not the creation of an organic soil-like material. Rather, the goal is the rapid decomposition of carcasses that results from the active thriving microorganism population and the pasteurization that occurs via the accompanying elevated temperatures. This temperature goal is accomplished when the compost exceeds 130° Fahrenheit for at least 5 days. The elevated temperatures have the effect of pasteurizing the compost material and providing pathogen control benefits. The elevated temperatures also increase the rate that the mortality is broken down and blended into the final compost mixture, leaving at most a few larger bones. There should be no remaining soft tissue. This rapid decomposition and pasteurization process is the result of the intentional management of the carbon, nitrogen, water, and oxygen (C, N, H_2O, O_2,) content of the composting material.

Balancing the Carbon to Nitrogen Ratio

In order for microorganisms to rapidly decompose mortality at elevated temperatures they need both carbon and nitrogen. The ideal carbon to nitrogen (C:N) ratio for compost is 30:1, with an acceptable ratio ranging from 15:1 to 35:1. The primary source of nitrogen will come from the poultry mortality. If poultry litter is being used as a carbon source it will likely also be a significant source of nitrogen. In contrast, other carbon sources such as wood shavings will supply very little additional nitrogen. In order to achieve the desired C:N ratio for the overall compost it is important to know the respective C:N ratio for each added ingredient. Table 1 provides the C:N ratio of potential compost ingredients.

There are multiple ways to calculate the proper amount of carbon and mortality used in order to achieve a compost with a desired carbon to nitrogen ratio. Figure 1 depicts a visual example, using a Pearson Square, of how to calculate input percentages using two variables (each with a known C:N) and a desired C:N. There are three mathematical examples shown in Figure 1. The first and second examples utilize a high carbon input (wood shavings, rice hulls) and set the desired C:N ratio for the compost at the optimum value of 30:1. The third example shows input percentages for using only litter and carcasses. Notice that the carbon to carcass input ratio is much higher in this example and that this still only achieves a less efficient and suboptimal C:N of 15:1.

When utilizing a bin composting technique, the carbon material provides important attributes in addition to being a feed stock for the composting process. The initial bottom layer of carbon material and the carbon material placed between the mortality and the bin side walls serves as a moisture absorbent barrier, which provides environmental protection by preventing mortality leachate from migrating to ground and surface water. This carbon material combined with the top capping layer also serves as an air filter to minimize odors and reduce the potential to attract scavengers. Therefore, because of the encasing carbon cap associated with bin composters the C:N ratio for all the material in the bins will potentially be higher than 30:1. If there is additional carbon available the potential exists to utilize a portion of the composted material as a third ingredient in the compost ratio.

It is also important to note that some carbon sources break down more readily than others. This difference in decomposition rates can be a function of the particle size or the source material itself. For example, straw is commonly suggested as a carbon source, but is often avoided due to its slower decomposition, which can lead to feeding problems in litter spreader trucks during land application.

Critical Moisture Content

The moisture content of healthy compost needs to be between 40%-60%. Below 40% and the environment will be too dry for the composting microorganisms to thrive and for decomposition to occur. Rather, there is a potential for desiccation and preservation to occur within the pile. Above 60%

moisture, oxygen movement into the compost mixture will likely be reduced causing the aerobic microorganisms to be replaced with anaerobic ones, which will result in more odorous decay products. A quick effective test of moisture content is to squeeze a hand full of compost. At an acceptable moisture content the material should clump together. If it is dry and crumbly additional water is likely needed. If squeezing the compost results in dripping liquids, the moisture content is likely too high. When assessing moisture it is important to note that the squeeze test is only practical well into or near the end of the composting process. During the initial stages of the compost process there will be more moisture due to the water added to the carbon source and the moisture present within the morality. As a result, moisture management must consider the "average" initial moisture content and the rate at which moisture is lost during composting. Fortunately, the composting process is fairly forgiving and experience can be a reliable guide. It is usually easier to add moisture when the mixture is too dry, than carbon when it is too wet. Therefore, it is typically advisable to have a slightly dry than an overly wet mixture.

Potential impact on ingredient characteristics and moisture on the Compost oxygen level

The fourth important factor that needs to be managed is the oxygen level of the compost mixture. The microorganism's access to oxygen is influenced by the particle size of the carbon source and the mixture's moisture content. The particle size needs to be small enough to ensure good contact between the carbon source and the mortality. In addition, smaller particles are easier for the microorganisms to decompose. However, if the particles are too small the amount of space between them potentially limits oxygen movement from outside the compost mixture to the microorganism. As indicated earlier, excessive moisture levels can contribute to restricting access to necessary oxygen. Compaction of the material due to the weight of the material above can also restrict oxygen levels. When increased oxygen levels are desired, mechanical mixing or turning are the most common option. For rotary drum composters, this is accomplished automatically by the drum rotations that take place daily. For bin composters, aeration is accomplished when the material in the primary bins is moved to the secondary bin.

Composter Type, Sizing, and Daily Management

In Arkansas poultry mortality composting is typically done in either two stage bin composters or rotary drum composters. While the equipment, facility design, and daily management details differ, the underlying composting goals and principles remain the same. It's beyond the scope of this article to cover all of the details and variations for each different type of composting design, but in the end it is the owner/operator's preferences which determine the style of daily mortality composting system to put in place. Once the composter style is decided, the composter's size, location, and daily management requirements need to be determined based on the highest expected amount (by weight) of daily (non-catastrophic) mortality. Farm records and/or other information are used to express the daily mortality in pounds per day. Next, the desired type and amount of carbon source is determined. Then, the composter and any associated storage structures are sized, designed, and constructed. While associated structures will add to the cost of the composting facility, they help meet composting goals by providing needed dry storage for carbon source and compost. Daily mortality composting management revolves around the process of adding the mortality to the composter with the correct amount of carbon material and adding any additional moisture needed. The added quantities will vary with mortality loading. Compost thermometers help verify that the carbon, nitrogen, moisture and oxygen levels are within the desired ranges. This thermometer should ideally indicate that the internal compost temperature exceeds 130° Fahrenheit for at least five days. Once completed, the pathogens should be pasteurized and resulting compost product should have no soft tissue present, although a few larger bones may remain.

Sources and Additional information are available via the references below.

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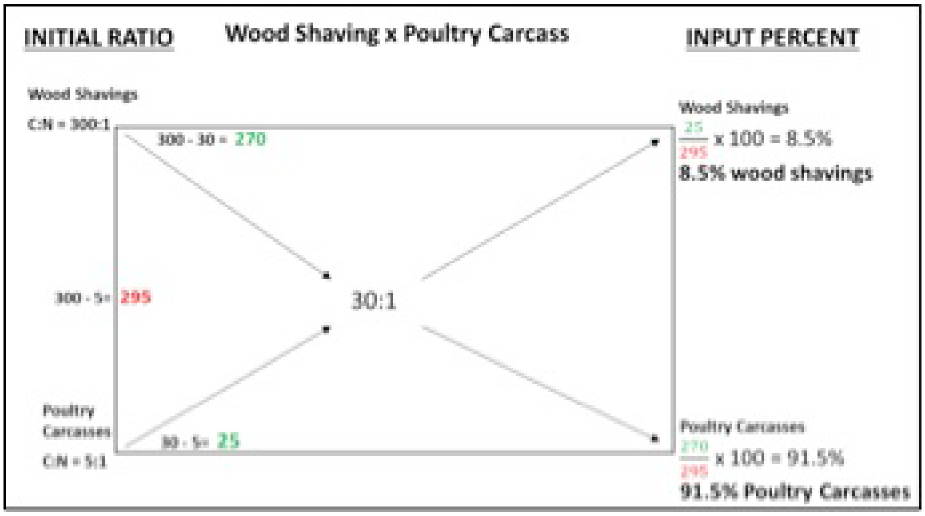
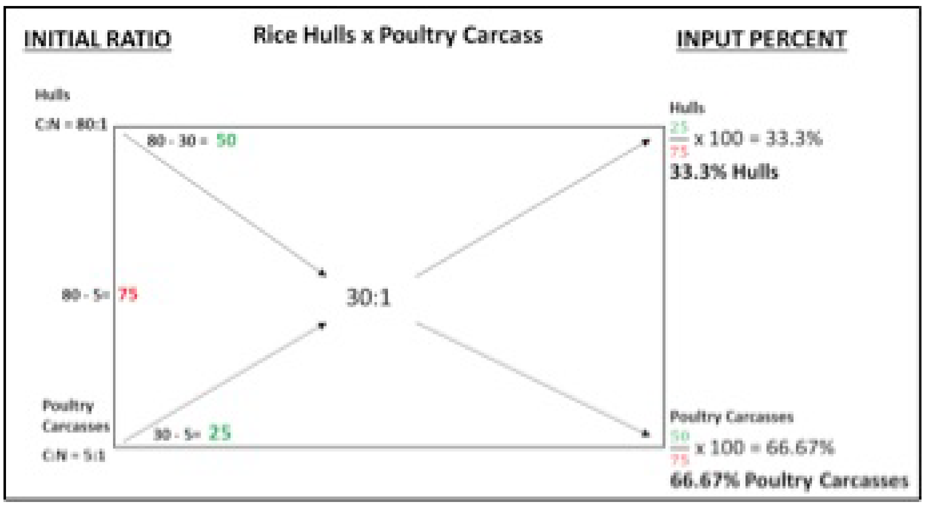
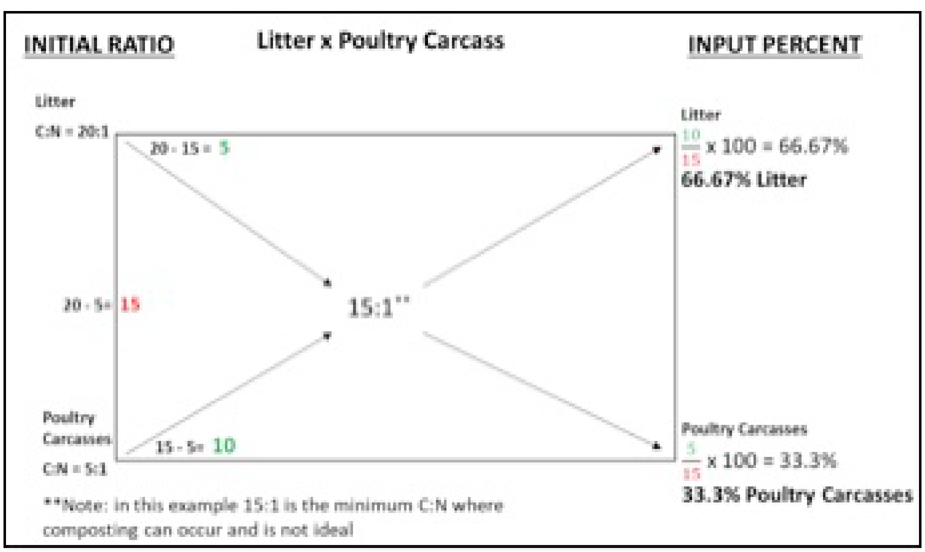
Table (1)

Carbon to Nitrogen Reference Table	
Source	**C:N**
Poultry	5:1 - 10:1
Poultry manure (fresh)	10:1
Poultry Litter	7:1 - 25:1
Straw	40:1 - 150:1
Wood chip/shavings	200:1 - 800:1
Sawdust	100:1 - 500:1
Paper	170:1 - 200:1
Rice Hulls	45:1 – 170:1
Peanut Hulls	50:1
Corn stalks	50:1 - 100:1
Pine needles	60:1 - 100:1
Grass clipping	15:1 - 25:1

Figure 1:







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