FEEDING MUSHROOMS

The 'ins' and 'outs' of nitrogen in mushroom compost

By Meghann Thai and Michael Kertesz

Remember the slogan "Meat for Vegetarians"? Button mushrooms contain around 3 g/100 g protein. This is similar to mung bean sprouts and slightly lower than chickpeas, but considerably higher than most vegetables.

While protein is a valuable portion of the dry matter (DM) in mushrooms, its content is quite variable, ranging from 14-30%. Dry matter itself ranges from a low as 7% up to 14%. High DM content and, therefore, high protein content, is associated with firmer mushrooms and improved shelf life.

Important amino acids, such as leucine, lysine, and tyrosine, are the building blocks of the majority of protein in mushrooms. Nitrogen is an essential component in all of these compounds. It is therefore unsurprising that the nutritional content of mushrooms is strongly correlated to the nutritional quality of the substrate on which they have been grown.

Nitrogen is one of the most important elements in mushroom composting and cropping. Button mushrooms are grown on a composted substrate made from wheat straw, poultry manure, and gypsum.
See p24 for more on nitrogen in poultry litter.

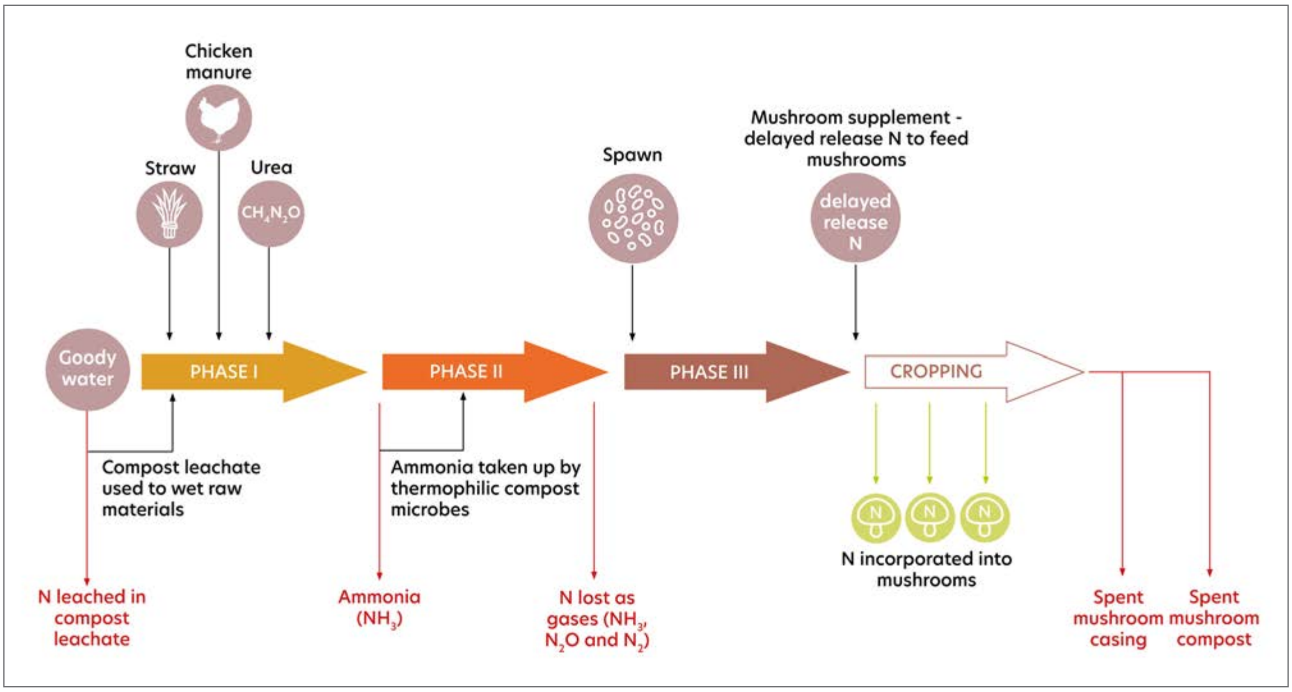


Figure 1. Nitrogen transformation throughout mushroom composting and cropping. Nitrogen inputs, losses and outputs are indicated by the black, red, and green arrows, respectively.

The inputs and outputs of nitrogen in mushroom composting are summarised in Figure 1.

At the start of composting, composters adjust the ratios of their raw mixtures to meet the desired C:N ratio of 35:1. Poultry manure is the primary source of nitrogen in mushroom compost, contributing approximately 40-50% of the total nitrogen in the initial feedstocks. Wheat straw adds another 20-25% of the total nitrogen, and additional nitrogen can be provided using organic sources such as cottonseed meal or soybean meal.

Inorganic nitrogen sources such as ammonium nitrate, ammonium sulphate or urea can also be used. These additional nitrogen feedstocks usually contribute approximately 3-5% of the total nitrogen at the start of composting.

Compost leachate ('goody water'), which is recycled from the previous compost crop, is used to wet the raw materials and makes up the remainder of the nitrogen balance. Although some nitrogen is potentially lost during prewetting as goody water runoff, adding this to the next compost batch means the net loss of nitrogen is likely minimal.

There are several ways in which nitrogen is lost during the composting process. During Phase I, the microbially intense process of composting is typically characterised by a strong ammonia (NH_3) odour. The NH_3 is released due to proteolysis (enzymic breakdown of proteins into amino acids) and heat generated by the microbes in the feedstocks.

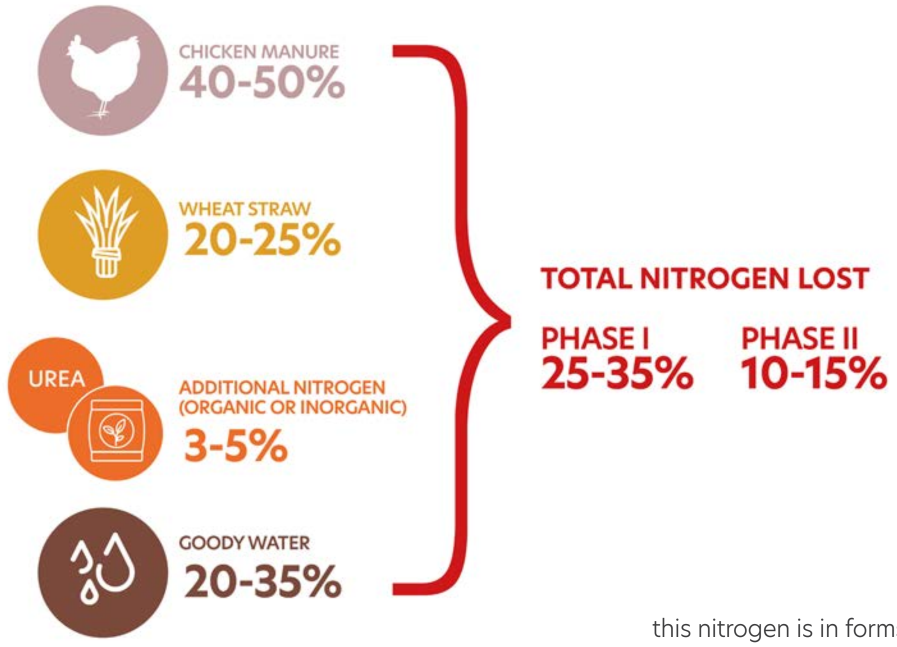
By the end of Phase I, approximately 25-35% of the nitrogen inputs from the start of composting have been lost. However, it is difficult to fully quantify how much of the nitrogen loss during Phase I is from ammonia volatilisation or due to goody water runoff.

During Phase II, the free ammonia from Phase I is used to aid in pasteurisation. It is then re-assimilated back into the compost by thermophilic microbes during conditioning, producing biomass. Although this stage of composting is conducted inside an enclosed tunnel, a further 10-15% of nitrogen is lost during Phase II, most likely in the form of nitrogenous gases.

By the end of Phase II, only 40-50% of the total nitrogen from the initial feedstocks remains. During Phase III, protein from the grain in mushroom spawn offers a small amount of nitrogen. However, the mushrooms gain most of their nitrogen from the microbial biomass in the compost.

After Phase III, commercial supplements contribute approximately 10-15% of nitrogen used during cropping. Commercial supplements are designed to release

NITROGEN INPUTS AT THE START OF COMPOSTING



nitrogen slowly over time. This maximises nitrogen availability for the mushrooms during consecutive flushes.

Nitrogen becomes an output when mushrooms are harvested. Total nitrogen in button mushrooms increases over consecutive flushes; total nitrogen content of first flush and third flush mushrooms is approximately 5% and 7% of dry weight respectively.

When total nitrogen is converted to approximate protein content, 5-7% total nitrogen corresponds to approximately 30-33% protein in the mushrooms. By the end of cropping, approximately 50% of the nitrogen inputs from composting and cropping are left over in the spent mushroom casing and compost. However, most of this nitrogen is in forms that cannot be accessed by the mushroom mycelium.

Improving nitrogen management throughout composting could provide a major financial benefit for the mushroom industry, improving efficiency of nitrogen uptake and accumulation of dry matter. Unfortunately, not enough is known about where and how nitrogen is lost during composting.

Research on developing a mass balance model on nitrogen inputs and losses during composting is currently underway. This includes measuring nitrogenous gases during Phase II and maximising nitrogen output in mushrooms.

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Further reading

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