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Peat and alternative materials for mushroom casing

This factsheet provides information on optimising mushroom casing using peat and its alternatives. It describes steps that may be taken by growers during preparation and watering of casing to improve mushroom yields and quality, and minimise problems such as bacterial blotch.

Peat has been the major component of mushroom casing for over 50 years and accounts for about 2.5% of the four million cubic metres of peat used annually in the UK. However, the UK horticulture industry, including mushroom production, is under environmental pressure to reduce the consumption of peat.

To be economically competitive with peat, any substitute material must produce a similar mushroom cropping performance and be available in sufficient quantity and at a competitive price. Ideally the peat alternatives must give other benefits such as the suppression of bacterial and fungal diseases, although this aspect has not been fully investigated.

Most of the information in this factsheet has been gained using white hybrid strains; the requirements of brown mushroom strains may be somewhat different. Inclusion rates of casing ingredients quoted in this factsheet are on a volume basis.

Figure 1. Trays with casing containing 12.5% bark or green waste compost

Action points

- Investigate using proportions of cooked-out recycled casing, composted bark fines and green waste compost (GWC) in peat casing; these can be added to the casing hopper with additional water.
- Recycled casing must not contain disinfectants or significant amounts of salt used for disease control.
- GWC should be matured for at least nine months and have an electrical conductivity of less than 1,100µS/cm.
- Check the moisture status of the casing on application and during cropping by taking and drying samples or by using moisture meters and tensiometers.
- In the event of bacterial blotch, check casing after the second flush for blotch-causing *P. tolaasii* by testing with a TaqMan PCR diagnostic test. Use at least two casing materials to check whether the blotch is due to the casing or cropping conditions.

Peat and lime sources

Casing must have a high water holding capacity and materials with a volumetric water retention at saturation of at least 67% have been found to be more suitable than materials with a lower water retention when saturated. Conversely, casing must have sufficient porosity to prevent anaerobicity; the optimum air filled porosity of casing is around 19% v/v. These physical requirements of casing have been met by various sources of peat.

Until the early 1990s, mushroom casing in the UK was prepared from milled sphagnum and sedge peats, which were allowed to dry before transportation and then rewetted, for example, by soaking, before use. Since then, the predominant ingredient in mushroom casing has been bulk extracted (wet dug) sphagnum peat, which is transported and blended in a near saturated form. Irreversible damage to the particle structure of milled peats caused by drying means that they hold less water when saturated than wet dug peats. This has not necessarily resulted in higher mushroom yields from casings prepared from wet dug peats than milled peats. The main benefits of wet dug peats have been the avoidance of surface 'panning' caused by heavy watering of casings prepared from milled peats and they do not need pre-mixing before application.

Figure 2. Casing prepared from wet dug peat

Casing containing milled peats also has a tendency to produce more mushroom primordia, resulting in smaller mushrooms than casing prepared from wet dug peats. Particles of very young or 'blonde' peats can stick to mushroom caps. However, decreasing availability of wet dug peat for mushroom casing is a problem not only in Britain but also in the Netherlands and Belgium. Although extraction of wet dug peat has curtailed in the UK, other sources of peat are still available in quantity for different horticultural sectors. These include black humified peats for blocking media, which have similar physical requirements to peat for casing, as well as by-products (peat fines) which are grade-outs from other horticultural peats.

Chalk or lime sources are added to peat to increase the pH of the casing to around 7.5. Sugar beet lime (SBL) largely replaced ground or lump chalk in casing because it has a clay-like structure, giving the casing a sticky texture. However, it too has become less widely available in recent years due to the closure of several sugar beet processing factories in Britain and Ireland. Chalk or SBL is usually added to casing at around 9%. Higher inclusion rates increase the bulk density and cost of the casing without improving mushroom yield or quality.

Figure 3. Casing containing 25% recycled casing, on elevator

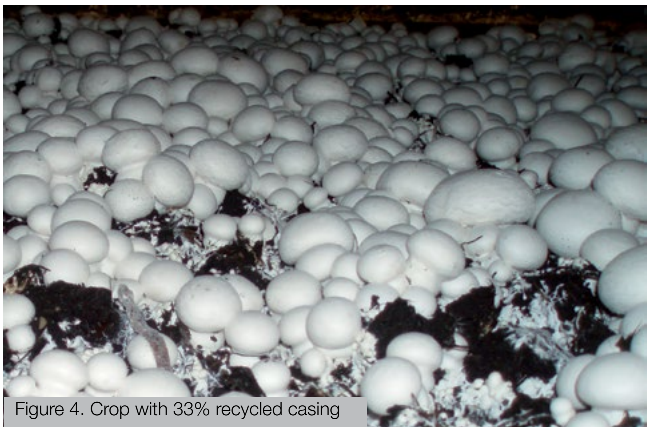

Figure 4. Crop with 33% recycled casing

AHDB Horticulture research project M 60 has shown that casing prepared from partially dried blocking peat, milled peat fines and fine particle ground chalk (<2mm grade) can produce mushroom yields and quality similar to those obtained using wet dug peat and SBL casing. Although there is no need for pre-soaking the peat, the blend requires pre-mixing and watering in a casing hopper and more frequent and smaller waterings than casing prepared from wet dug peat.

Alternative materials

A wide range of materials have been examined as potential alternatives to peat in mushroom casing. Some of these have been shown to be unsuitable, even at inclusion rates of 25% or less. These include materials with:

Insufficient water holding capacity
Wood fibre
Lump chalk
Lignite

Excessive soluble nutrients
Spent mushroom compost (SMC)
Digestates

Conduciveness to *Trichoderma* and other moulds
Recycled coir
Paper wastes

Prohibitive cost
Coir
Vermiculite

Insufficient supplies in the UK
Sugarcane bagasse
Tea and coffee wastes

Other peat alternatives at high inclusion rates (>50%) have also generally given inferior results to peat casing due to excess porosity and reduced water holding capacity of the casing. However, several materials can replace up to 33% of the wet dug peat in casing without affecting the yield or quality of mushroom crops. At inclusion rates of 33% or less, the materials can be added to peat casing in a mixer or in the casing hopper with additional water sprayed on.

Recycled casing

Mixed SMC requires a lengthy period (usually two years or more) of leaching to reduce the soluble nutrient content and even then, mushroom yields are often inferior to those obtained with peat casing. However, separated spent casing can be used to form up to 33% of fresh casing, providing the material is cooked-out or pasteurised and does not contain disinfectants.

Trays or shelves that have been heavily salted for disease control should not be used and, if possible, salt patches should be removed after cook-out.

Separated casing can be reused immediately after it has been cooked-out, although material from machine harvested crops in the Netherlands is first composted for three weeks due to the large amount of mushroom stumps left on the casing.

Attempts to remove the casing layer from mushroom beds after cropping by inserting a plastic mesh layer between the compost and casing layer during shelf or tray filling have reduced mushroom yield. However, a machine for separating casing from the compost at emptying has been developed by Mush Comb in the Netherlands.

The separated casing should first be rewetted by adding water to a bulk container; the wetted material can then be added to fresh casing in the filling hopper of the shelves or trays.

Bark

Composted pine bark fines are the most suitable grade of bark products for casing due to small particle size and lack of terpenes. The effects of adding 25% bark fines to peat casing on mushroom yield have been inconsistent between trials. However, the addition of 12.5% of bark fines or 6.3% each of bark fines and GWC, together with additional water, to peat casing was either beneficial or neutral to mushroom yield in trials.

Figure 5. Composted bark fines

PAS100 Green waste compost (GWC)

GWC that has been matured for at least nine months so that it is stable can be used as a casing ingredient. GWC is unsuitable at an inclusion rate of 25% but at 12.5% has no overall effect on mushroom yield or quality. It is best used at 6.3% in conjunction with a similar volume of bark. Composts with a low soluble salt content (electrical conductivity <1,100µS/cm) should be used.

Figure 6. Matured GWC

Coir

Coir has previously been used in commercial casing blends in the UK at inclusion rates of up to 20%. Trials in M 38 and elsewhere have shown that satisfactory mushroom yields and quality can be obtained from casing containing at least 50% coir. However, due to increasing global demand for coir in horticulture, the cost of such casings will be significantly higher than peat-based casings, without mushroom yield or quality benefits. Coir containing long coconut fibres can result in hair-like particles sticking to the mushroom caps.

Granulated rockwool slabs

Flocculated rockwool is not a suitable casing ingredient because mushroom mycelium does not penetrate the flocks. However, good mushroom cropping results have been obtained with casing containing 25% waste granulated rockwool slabs from glasshouse tomatoes and cucumbers. The recycled material is currently classed as waste and therefore cannot be used commercially.

Filter cake clays

Multi-roll filter cake (MRF), a clay filter cake by-product from the coal mining industry, was developed as a commercial casing ingredient and used by some mushroom farms for several years. Clay-like filter cakes are also produced by sand and aggregate washing plants. Its pale colour means that these filter cakes are more attractive as a casing ingredient than MRF. Due to similar physical characteristics, filter cakes have the potential to replace SBL, although they require special blending equipment. However, unlike MRF, which can be used as a casing ingredient, other filter cakes are currently classed as a waste and cannot be used commercially.

Mixing, blending, wetting and application

To speed up colonisation of the casing, mushroom mycelium is mixed into the casing before application as caccing (Phase 3 compost) or sterile casing inoculum (CI), or by machine ruffling after the casing has been applied. Typical inclusion rates in the casing are 6–9kg/m3 for caccing and 1–1.5kg/m3 for CI.

Previous work has shown that the optimum depth of the casing for mushroom yield and quality is around 50mm. Shallower casing results in reduced yield, whereas a deeper layer reduces mushroom firmness and dry matter content and wastes casing.

In trials, maintaining a casing water volume of at least 61% during cropping produced a better yield than maintaining a lower water volume. The moisture content of the casing can be checked by oven drying a known volume of casing or by using a handheld moisture sensor and meter.

However, the moisture holding characteristics of casings vary according to different peat and alternative materials. For comparing moisture levels in different casing materials, it is necessary to measure the water 'tension'; this can be achieved by inserting a tensiometer in the casing (figure 7). A typical output shows that after application, water tension in the wet casing is small (figure 8). As mushrooms in the successive flushes draw water out of the casing, the water tension increases rapidly and then falls as the casing is watered after the flush has been picked.

Although there are fewer mushrooms in the third flush than in the first two, water tensions are usually higher because it is not possible to rewet the casing to its original level, partly due to the mushroom mycelium making the casing more water repellent (hydrophobic). It is therefore important to apply sufficient waterings after each flush, without allowing water to over wet the underlying compost.

Casing watering can affect the quality of mushrooms in terms of cleanness, firmness, dry matter content, whiteness, resistance to bruising and the occurrence of water stress symptoms (see AHDB Horticulture Factsheet 15/04: Optimising mushroom quality).

Figure 7. Tensiometer for measuring casing water tension

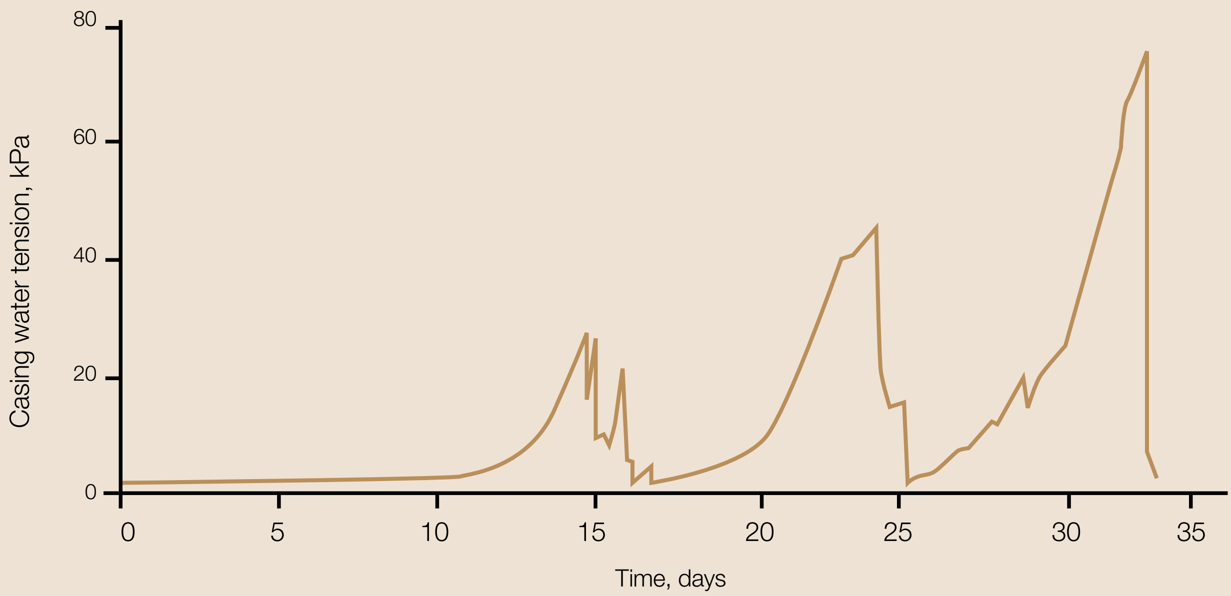

Figure 8. Typical output from a tensiometer in casing during a mushroom crop

Casing materials and bacterial blotch

Pseudomonad bacteria are needed in casing to stimulate mushroom primordia to form, although some species (*Pseudomonas tolaasii* and *P. gingeri*) are responsible for causing bacterial blotch and ginger blotch (figures 9 and 10).

The occurrence of blotch is not usually related to the initial pseudomonad population in casing materials, although there is some evidence that using caccing instead of CI may encourage blotch by introducing blotch-causing pseudomonads present in the Phase 3 compost.

The occurrence of ginger blotch has also been linked with the use of some sources of peat. There is a large increase in the casing pseudomonad population during the life of a crop because they utilise volatiles released by mushroom mycelium; casing materials differ in the size and types of pseudomonad populations that develop. If mushrooms remain moist before harvest, the blotch can develop, particularly on casing materials that are conducive to the development of blotch-causing pseudomonads.

Blotch diagnostic test

A TaqMan PCR test is available for testing for the presence of blotch-causing *P. tolaasii*. Positive test results (CT values less than 33) in casing after the second flush have generally corresponded with the occurrence of moderate or severe bacterial blotch.

In the event of a blotch problem, testing of casing during the cropping period using the TaqMan PCR test for *P. tolaasii* may help to identify casing materials and environmental conditions that are conducive or inhibitory for the disease. However, the TaqMan PCR test does not detect *P. gingeri.*

Using at least two different casing materials in the same cropping room may help to identify whether the blotch or ginger blotch problem is related to the casing material or caused by the prevailing cropping conditions.

Figure 9. Primordia are stimulated to form by casing pseudomonad bacteria

Figure 10. Mushrooms with bacterial blotch

Further information

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AHDB Horticulture project reports are available at horticulture.ahdb.org.uk/sector/mushrooms

- M 54: Mushroom casings: Screening of microbial populations in relation to mushroom quality.
- M 55: Mushrooms: Desk study/literature review of the potential alternative materials to peat in mushroom casing.
- M 60: Developing alternatives to peat in casing materials for mushroom production.

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