Project title:	Mushrooms: Desk study/literature review of the potential alternative materials to peat in mushroom casing
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Project leader:	Ralph Noble, East Malling Research
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Industry Representative:	Dr John Collier, Monaghan Mushrooms
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AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

[Name]
[Position]
[Organisation]

Signature .... Date ....

[Name]
[Position]
[Organisation]

Signature .... Date ....

Report authorised by:

[Name]
[Position]
[Organisation]

Signature .... Date ....

[Name]
[Position]
[Organisation]

Signature .... Date ....

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GROWER SUMMARY

Headline

- A review of 71 publications and consultations with casing manufacturers and other researchers has shown that there are currently no peat substitute materials available or sufficiently developed in the UK for use in mushroom casing that compare with peat in terms of cropping performance and price.

Background and expected deliverables

The UK horticulture industry, including mushroom production, is under environmental pressure to reduce the consumption of peat. Mushroom casing accounts for about 2.5% of the four million cubic metres of peat used annually in the UK. 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. There has been a considerable amount of research and development work on the use of different casing materials to substitute or replace peat.The objectives of this review were:

1. To conduct a literature review on previous research and development work on the use of alternatives to peat in mushroom casing.

2. To contact casing and growing media companies and other researchers to determine what is currently available and being tested.

3. To assess the availability and cost of potential casing materials to the UK mushroom industry, and the impact of waste and other regulations on their use.

4. To incorporate the findings in future research and development work and to disseminate the results to the mushroom industry.

Summary of the project and main conclusions

Peat is still the major component of mushroom casing in developed countries, and even where peat is not locally available, it is imported for this purpose. Information on the use of different casing materials was obtained from 71 references in scientific journals, conference proceedings, technical articles, research reports and patents, as well as from consultations with casing producers and other researchers. Comparison with peat-based casing materials was possible using information from 42 of 71 references.

Overall, there was a weak negative relationship between the proportion of peat substituted in casing and mushroom yield. The most promising materials for peat substitution in the UK are recycled granulated rockwool and recycled spent casing. Wood fibre and mature PAS 100 green waste compost are also potential materials but there is no information on using them at low inclusion rates in peat-based casing. By-product clays and silts can be used in casing; at inclusions rates below 20% v/v they can be considered to be sugar beet lime replacements but at higher inclusion rates, they can also substitute peat in casing. Coir has been used to a limited extent in casing, at inclusion rates of <20% v/v, but the practicalities and economics of using coir on a large scale are doubtful.

Spent mushroom substrate and anaerobic digestate, even after storage and leaching, are unsuitable casing ingredients, mainly due to high EC. Bark and paper waste products have also been investigated by several workers; watering of bark casing can be difficult and paper wastes can encourage the growth of competitor moulds.

Casing materials can have a large effect on mushroom quality, particularly cleanness, as well as whiteness, and possibly cap spotting caused by bacterial blotch and *Trichoderma* sp.

There was a weak negative relationship between casing EC and mushroom yield, although EC values of 1 mS/cm or less had no effect on yield. Overall, none of the physical properties of the casing materials measured in the references were significantly correlated with mushroom yield.

There are currently no parameters for defining the properties of the best peat or peat substitute casings. Low EC, high water holding capacity at a range of matric potentials and a defined bulk density are probably the most important criteria in selecting materials that may be suitable for use in casing but this requires further investigation.

Waste License regulations are currently inhibiting the utilization of certain peat substitute materials such as clays and silts from mining. This should not affect separated spent casing which can be recycled on the same site.

Main conclusions

With the exception of coir, there are currently no peat substitute materials available in the UK for mushroom casing, without the need for further development work and/or exemption from Waste License regulations. However, coir is a more expensive material than peat and the practicalities and economics of using this material at inclusions rates >15% v/v are doubtful.

Financial benefits

The cost of new casing could be reduced by recycling separated spent casing into the mix. It is unlikely that other substitute materials will significantly reduce the cost of peat-based casing since transport costs are also substantial. The quantity of sugar beet lime in casing could be reduced by partial substitution with cheaper clays and silts to produce similar physical characteristics.

Action Points

- The feasibility of separating spent casing from spent compost on emptying cooked-out growing rooms and re-use in new casing needs further investigation.

- The effect of adding small proportions of wood fibre or mature PAS 100 green waste compost into casing on mushroom yield and quality should be examined.

- The industry needs to engage with the Environment Agency to allow the use of safe by-product materials as peat substitutes without the requirement for Waste Licenses.

Further research and development

Based on the findings of this review, the most promising materials for further research and development on peat substitutes in mushroom casing in the UK are:

- recycled spent casing
- recycled granulated rockwool
- dewatered clays and silts
- wood fibre
- PAS 100 mature green waste compost (screened to a fine particle size).

SCIENCE SECTION

Introduction

Since the 1950s, peat has been the major component of mushroom casing in the UK and all other countries where the material is locally or economically available. This is mainly due to its good water holding characteristics and low contents of soluble salts and nutrients. General freedom from pests and pathogens obviates the need for pasteurising peat, a further advantage over soil, which was the main casing material until the 1950s. Even in countries where peat is unavailable for extraction, such as Australia and South Africa, large quantities of peat-based casing material are imported from Europe and North America, and peat substitute materials such as composted wattle bark or coir are used only to a limited extent. In other peat-free regions of the world such as France, Spain and eastern China, where casing has traditionally be made from locally available mineral soils and additives, there has been an increasing trend to incorporate peat into the casing mix (Vedie, 1995; Noble *et al*., 2001; Pardo *et al*. 2010a).

The combined professional and amateur sectors of UK horticulture use around 4 million cubic metres of peat annually (Anon. 2010a). In the last 20 years, the annual volume of casing used in the UK has declined from around 270,000m^3 to around 100,000m^3 (Scotts, personal communication). However, the introduction of shorter, two-flush cropping cycles, and the recent resurgence in the UK mushroom industry, indicates that this latter figure is likely to stabilise or increase.

The UK horticulture industry has been under environmental pressure since the early 1990s to reduce the consumption of peat (Pryce, 1991). In line with Government and consumer pressure, multiple retailers are now also pressurising their suppliers, including mushroom producers, to reduce their usage of peat. Originally this pressure was due to the impact of peat usage on wetland habitat destruction and biodiversity, but the impacts on CO_2 emissions and climate change has increased this pressure. This led to unrealistically high levels of peat replacement being set by Defra under the UK Biodiversity Action Plan: 40% peat free by 2005 and 90% peat free by 2010 (Anon. 2010a).

Pryce (1991) recognised that finding suitable peat alternatives for mushroom casing may be more challenging than in other horticultural sectors. Pryce (1991) recommended further investigations into the use of waste composts, SMS, paper sludge composts, polystyrene, vermiculite, new rockwool and coir as mushroom casing. However, since 1991, only coir has been used in commercial casing in the UK, and at inclusion rates of less than 20% v/v.

In some areas of horticulture, particularly the retail sector, green waste compost has made a significant impact on peat substitution, partly due to the greater availability of this material following the diversion of organic wastes from landfill in line with the EU landfill directive (Anon., 1999a). Used alone, the material is unsuitable as a casing material, even after extended storage, but the material could be used at low inclusion rates (Lelley *et al*., 1979).

There has been a considerable amount of research and development work on the use of different casing materials to substitute or replace peat, including that previously funded by the HDC in project M 38 (Noble & Dobrovin-Pennington, 2000). Some of this work has been conducted in countries where peat is locally unavailable; the aim being to find cheap, local materials which may not necessarily be available in the UK. 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. These latter requirements usually mean that the material is a by-product from another process. However, recent Environment Agency Waste Regulations have interfered with the use of industrial by-products as peat substitutes, for example clays and silts from mining and quarrying, and spent mushroom compost.

The objectives of this review were:

1. To conduct a literature review on previous research and development work on the use of alternatives to peat in mushroom casing
2. To contact casing and growing media companies and other researchers to determine what is currently available and being tested
3. To assess the availability and cost of potential casing materials to the UK mushroom industry, and the impact of waste and other regulations on their use
4. To incorporate the findings in future research and development work and to disseminate the results to the mushroom industry.

Methods

Information on the use of different casing materials was obtained from 71 references in scientific journals, conference proceedings, technical articles, research reports and patents. Some of the work was on casing materials that are not available in quantity in Europe, in containers that are too small to give commercially reliable results, and/or without a peat-based control material. Where appropriate, the data from these investigations was discussed but was excluded from the analysed results. This includes work on casings prepared from composted farm yard manure (Garcha & Sekhon, 1981; Guleria *et al*., 1989;

Shandilya, 1989), cotton gin mill wastes (Garcha & Sekhon, 1981), vermicomposts (Shieh & Wang, 1981; Tomati *et al*., 1989), treated cellulosic wastes (Clancy & Horton, 1981), wood fibre, composted vine shoots, soil (Pardo *et al*., 2010a,b) and fresh and composted anaerobic digester wastes (Levanon *et al*., 1984; Marchaim *et al*., 1991).

The following information from each reference was obtained:

(a) the materials investigated and the volumetric rate of inclusion (with peat, calcium carbonate sources, and/or other materials)

(b) treatment of the material before use (e.g. pasteurisation, composting, leaching)

(c) the yield of mushrooms obtained, compared with a peat control where available

(d) any effects on quality (negative and positive)

(e) influence on disease incidence

(f) relevant information on cultural details, e.g. watering, growing system, environment, mushroom strain

(g) physical, chemical and microbial properties of the casing ingredients and mixed casing

(h) information on the experimental design and replication.

In the majority of references, a calcium carbonate rate and type (lime, chalk, sugar beet lime) was specified. Where the rate of calcium carbonate ($CaCO_3$) was not specified, an average rate of 10% v/v was assumed. Where hydrated lime (calcium hydroxide) was specified instead of calcium carbonate, a rate of 5% v/v was assumed.

Results and Discussion

Casing materials

A list of the casing materials examined in the references in the review is shown in Table 1. Most of the work on peat substitution in casing has been conducted since 1978 using white or white hybrid strains of *Agaricus bisporus*. Most of the experiments were conducted without caccing or casing inoculum added to the casing or the use of such additives was not stated. Where stated, five or more replicates of each casing treatment were usually compared, although the statistical significance of difference between casing treatments was not always presented.

Inclusion rates of peat substitute materials ranged from 20 to 100% v/v. The material most frequently examined was spent mushroom substrate (SMS), usually after periods of storage and leaching. The other materials frequently investigated for use in casing were various types of bark, coconut pith fibre (coir), clay-like materials, and paper wastes (either before or after composting). Eleven of the materials were only examined in single investigations.

These materials include (a) inorganic materials: pumice, sand, gravel (b) heat expanded minerals: new rockwool, perlite (c) carbon sources: activated carbon, lignite (d) synthetic materials: Hygromull, Tempex, polystyrene beads, polyurethane crumb and (e) organic wastes: sugar cane mill mud, rice hulls, bagasse, anaerobic digestate, wood fibre. Most of these materials produce mushroom yields and/or have costs and availability that would not be of interest in the UK. Digestate is the residual material from anaerobic digestion. As with SMS, digestate had to be leached before use as casing to reduce its nutrient content and electrical conductivity (EC) (Marchaim *et al*., 1991), which would be difficult to achieve in the UK. Wood fibre was only investigated in a 20% v/v mix with soil and there was no comparison with or in peat-based casing (Pardo *et al*., 2010). However, comparisons in 20% v/v mixtures with 80% v/v soil showed that wood fibre produced a lower mushroom yield than peat, coir or composted green waste (Pardo *et al*., 2010).

Table 1. Casing materials examined in the review and the maximum and minimum rates used.

Material	**Rates, % v/v**		**References**
	Min	**Max**	
Bark	25	100	7
Clay	25	90	8
Coir	25	100	8
Limestone	33	100	3
Paper wastes	25	100	5
Rockwool used	25	100	3
SMS	20	100	11
Soil	50	100	3
Spent casing	50	100	3
Sugar beet lime	25	44	2
Tea waste	50	100	2
Vermicompost	50	100	2
Vermiculite	50	90	3
Waste compost	25	70	3
Others (11)	20	100	1

All the materials listed in Table 1 would be in sufficient quantities to satisfy the requirements of the UK mushroom industry with the exception of tea wastes and vermicomposts (insignificant quantities) and recycled rockwool (about 10,000 m^3 annually). The volumetric prices of several materials (coir, sugar beet lime, vermiculite) would be at least 50% higher than that of peat. Soil and SMS require treatment (pasteurisation and/or leaching) before they can be used in casing.

Sources of calcium carbonate are used in most casing materials. These sources include different size grades of chalk, lime, limestone, and sugar beet lime. They are usually incorporated in casing at inclusion rates of 10-15% v/v, but if incorporated at inclusion rates of ≥ 20% v/v they can be considered to be peat substitutes.

Peat sources used in casing are highly variable, as demonstrated in the range and physical and chemical properties in HDC Factsheet 40/97 (Noble *et al*. 1997). In UK and Irish casing, there has been a gradual shift from milled peat to wet deep-dug peat since the 1990s. This has largely been due to tendency of milled peat casing to surface ‘pan’ following heavy watering. In most references, the type of peat used, either in control casings or in blends with alternative materials, was not specified. Where the peat type was specified, sphagnum peat was usually used, although the type of sphagnum peat (dry milled or wet dug) was only specified in two of the references. Mainly sphagnum peat is used in casing but sedge peat can also be included (Barnhard 1974; MacCanna 1969; Buchanan & Barnes, 2003).

Effects of casing materials on mushroom yield

Comparisons with peat-based casings materials was possible using information from 42 of the 71 references sourced. In most of these comparisons, two or more peat substitutes or peat-reduced casing mixes were compared. Overall, there was a statistically significant and negative relationship between the percentage of peat substituted in casing and mushroom yield, although there was considerable scatter around this relationship, particularly at 0% peat (Figure 1). This relationship was the same for experiments with the 50% highest peat control mushroom yields as for the 50% lowest yields; i.e. the effect of peat substitution on mushroom yield was the same irrespective of whether the overall yields were high or low.

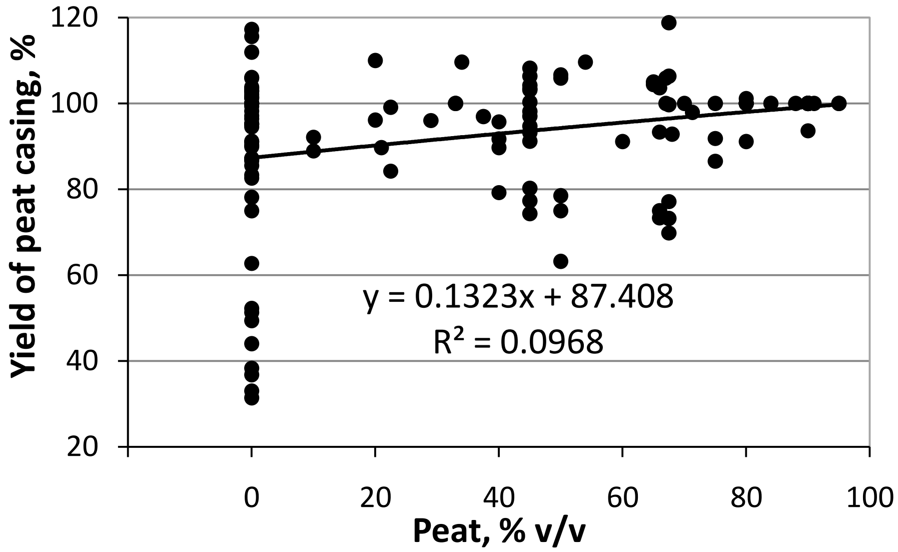

Figure 1. Relationship between the percentage of peat in casing and the yield of mushrooms, expressed as a percentage of yield obtained from peat-based casings in the same experiments.

Figure 2 shows the effect on mushroom yield of substituting peat in casing with (a) organic (b) inorganic/mineral and (c) mixed organic and inorganic materials. Results for organic materials (bark, coir, waste paper and waste compost) were variable, probably due to the different sources of materials as well as differing casing management such as watering (Figure 2a). Results obtained in HDC project M 38 showed that composted bark fines and coir could be used at 25% v/v in casing without significantly affecting mushroom yield, although both materials are more expensive than peat. Allen (1976) and Staunton (1983;1984) noted that bark casing required more frequent watering than peat casing. In South Africa, composted wattle bark is used on smaller mushroom farms (D. Dobson, personal communication).

Coir has been used in some commercial casing blends in Europe at about 15% v/v (Noble & Dobrovin-Pennington, 2001). This has usually been to improve the wetting characteristics of peat blends rather than for environmental reasons. Adding too much coir causes the structure of the casing being too open resulting in drying-out of the casing and damage to the mycelium (H. Breukers, personal communication).

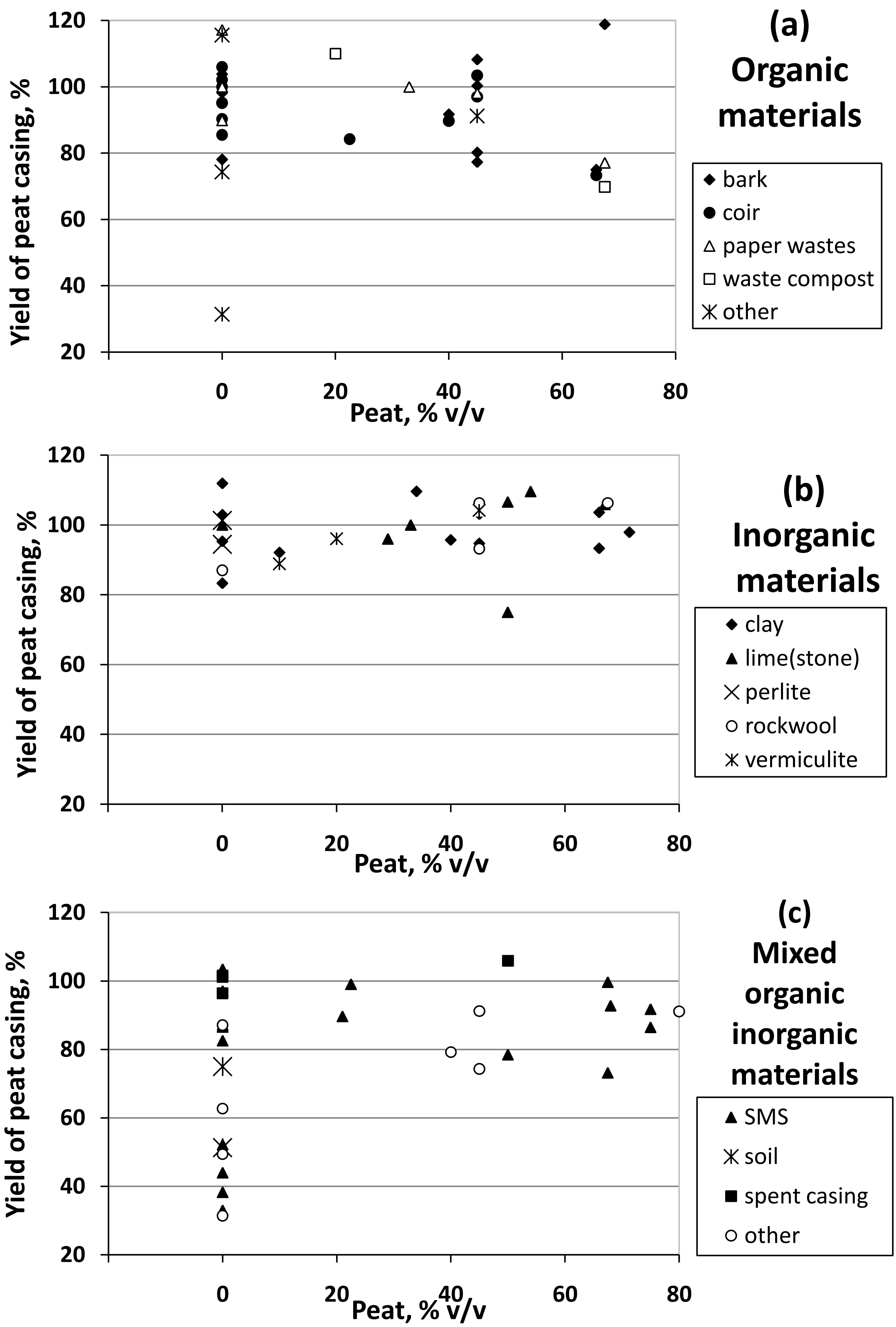

Figure 2. Effect of organic and inorganic casing materials on mushroom yield, expressed as a percentage of yield obtained from non-amended peat casings in the same experiments.

Mature green waste composts typically have an EC of 1-1.5 mS/cm, significantly lower than that of SMS (typically 3.5-5.5 mS/cm) (Noble 2005). Lelley *et al*. (1979) obtained variable results using composted municipal waste in casing and the material had a lower water holding capacity than peat-based casing. Results obtained with 25% green waste compost by Gerrits (1991) were poor although Pardo *et al*. (2010a) obtained mushroom yields of nearly 20 kg/m^2 using 20% green waste compost mixed with soil. Riahia and Zamani (2008) used composted azolla, a significant weed in Iran, but the mushroom yields were poorer than peat casing or spent mushroom compost.

Hayes *et al* (1978) obtained mushroom yields comparable with peat using casing made from paper mill pulp wastes. However, Dergham *et al*. (1991) and Noble & Dobrovin-Pennington (1998b) noted that paper wastes were prone to colonisation by competitor fungi such as *Coprinus* spp. Stoller (1977, 1978) and Rettig *et al*. (1997) patented casing mixtures containing paper wastes and various other materials including activated carbon, SMS, and limestone but none has proved to be commercially viable.

Levanon *et al*. (1984) and Marchaim *et al*. (1991) obtained mushroom yields with casing made from leached digestate that were comparable with peat-based casing, although the mushroom yields were less than 15 kg/m^2. Shieh & Wang (1981) and Dhar *et al*. (1993) showed that mushrooms could be grown on casings made from vermicompost but the availability of this material is very limited. Casing materials made from other organic wastes (sugar cane bagasse, tea waste or sawdust) have not been comparable with peat casing.

Inclusion of small particle inorganic materials in casing has generally resulted in better mushroom yields than inclusion of organic materials (Figure 2b). Inreasing the inclusion rate of $CaCO_3$ sources such as chalk and sugar beet lime from 5 to 30% by volume had little or no effect on mushroom yield but increased the cost of peat-based casing (Staunton 1982; Noble *et al*. 1999).

Although Barnhard (1974) obtained the same mushroom yield from a perlite casing as from a peat casing, it was very difficult to assess watering requirement of the perlite casing. Several workers have obatined reasonable yields using vermiculite as a casing ingredient but the material is more expensive than peat, and as with perlite and rockwool, requires a high energy requirement during production. Bentonite has also been used a casing ingredient in North America and New Zealand (Buchanan & Barnes, 2003) but it is an expensive material. Results with new rockwool flocks have been poor (Visscher 1988; Noble 1995) but results with granulated rockwool have been more promising and the material is waste by-product from the glasshouse industry. Various types of clay or silt materials have been used with some success (Kurtzman, 1995; Noble & Bareham, 2002; Beyer, 2004; Noble & Dobrovin-Pennington, 1995).This includes multi-roll filter cake (MRF), a by-prodcut of the mining industry, used by Tunnel Tech in casing. At inclusions rates of <20% v/v, these materials can be regarded as substitutes for sugar beet lime, since less SBL is needed to obtain a dense structure in the casing. This could involve a cost saving since clays and silts are cheaper (or free) compared with SBL, and cheaper liming materials than SBL could be used for adjusting casing pH. At inclusions rates >20% v/v, they can also be regarded as peat substitutes.

Starkey (1996) patented a casing formulation based on mineral fibres (rockwool), lignite, clay and chalk, but independent tests demonstrated the material was inferior to a commercial peat-based casing (Noble 1996), as well as being sifnificantly more expensive. Polyacrylamide gels have been used in casing materials including the commercial product Stocksorb produced by Stockhausen GmbH, Germany. Kurtzman (1996) examined the use of non-ionic gels in casing. These materials rapidly swell when water is added. They have been shown to improve the water uptake of dry growing media materials but they have not been shown to improve mushroom yields and their commercial uptake has been unsuccessful.

Soil was the standard material for casing before being replaced by peat in many countries during the 1950s. However, soil is still a major component of casing in some countries where peat is not available, notably Spain (Pardo *et al*., 2010a). There have been numerous investigations into the use of SMS as a casing material or ingredient. Results have shown that the material requires a lengthy period of leaching (usually 2 years or more) and dilution with peat, and even then, mushroom yields are often inferior to those obtained with peat casing (Figure 2c). Results with separated spent casing have been more promising than those for SMS (Nair and Bradley, 1981; Jablonski & Srb, 1989). Royse *et al* (2008) developed a method for removing the casing layer from mushroom beds after cropping by inserting a plastic mesh layer between the compost and casing layer during shelf filling. Where crops are cooked out, it may be unnecessary to pasteurise the spent casing before reuse.

Effects of casing materials on mushroom quality

Several workers demonstrated a negative relationship between mushroom yield obtained on different casing materials and the dry matter content of mushrooms (Noble *et al*., 1999; Barry *et al*., 2008; Pardo *et al*., 2010). Vermiculite, lignite and perlite had a tendency to stick to mushrooms (Noble, 1995; Noble & Gaze, 1995, R.G. Nielson Vitagrow personal communication).

Szmidt (1994) observed that mushrooms grown on casing containing SMS had less bacterial blotch than mushrooms growing on standard peat casing. Visscher (1988) found that casings with a pH of less than 7 increased the risk of damage to mushrooms from *Trichoderma* spp., although Rinker (2008) found there was no difference in *Trichoderma* incidence between casing pH values of 7.5 and 8.5.

Pardo *et al*. (2010a) found that of four peat/soil mixtures, a casing prepared from soil and black peat produced whiter mushrooms, measured by L* value, than the other three casings.

Relationships between casing properties and mushroom yield

Methods used for measuring the chemical and physical properties of casing materials were usually not described in the references and in only a few references (e.g. Noble *et al*. 1999; Pardo *et al*. 2010a) were standardised methods such as EN methods (Anon 1999b) used.

Several peat substitutes such as SMS increased the electrical conductivity (EC) of the casing. There was a weak negative relationship between casing EC and mushroom yield (Figure 3), although EC values of 1 mS/cm or less had no effect on yield. There was no significant effect of casing pH on mushroom yield (average value 7.52 ± 0.36).

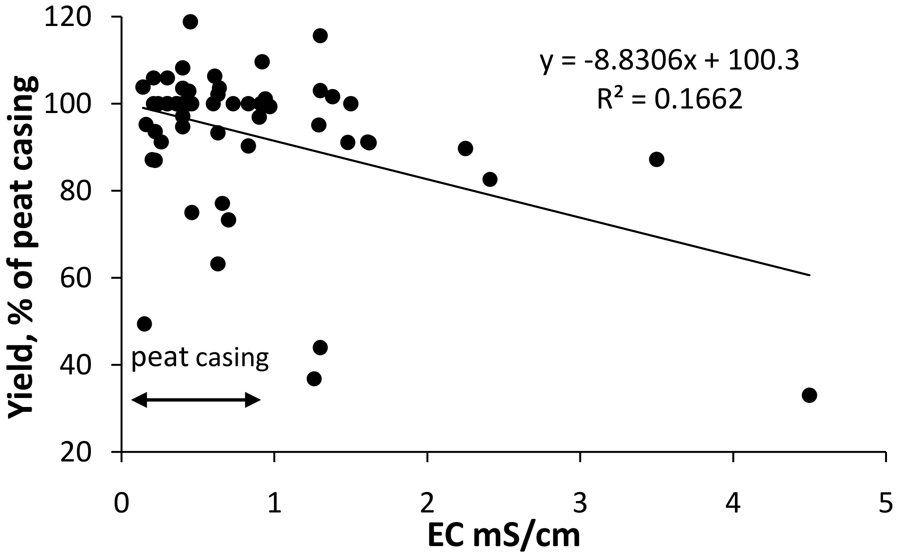

Figure 3. Relationship between electrical conductivity of casing materials and mushroom yield expressed as a percentage of yield obtained from non-amended peat casings in the same experiments. The range in EC of peat-based casings is shown by the arrow.

Overall, none of the physical properties of the casing materials measured in the references were significantly correlated with mushroom yield. These properties (and mean values) were water holding capacity (65% v/v ± 18), air filled porosity (22% v/v ± 11), and bulk density (651 g/L ±353). Rainey *et al*. (1986), Kurtzman (1995) and Seaby (1999) found that casing materials with high porosity or a more open structure cropped better than those with a dense structure. However, this may be due to the limited range of materials examined, with the denser materials being too dense or unsuitable for other reasons. As mentioned previously, addition of sugar beet lime and clay, which increase the density and reduce the porosity of peat casing, does not adversely affect mushroom yield. Visscher (1975) found that the optimum casing layers were those with a dense structure after application but more open structure after ruffling and before and during cropping. Pardo *et al*. (2010b) could find no relationships between the physical properties of a range of casing materials and their cropping performance. However, casings with lower porosity and a larger proportion of small particles <1 mm produced larger and fewer mushrooms. Water availability at different matric potentials (easily available and in-bound water) has been shown to be related to the cropping performance of casing materials, with a balance of easily available and in-bound water being desirable for casing (Noble &Dobrovin-Pennington, 1995).

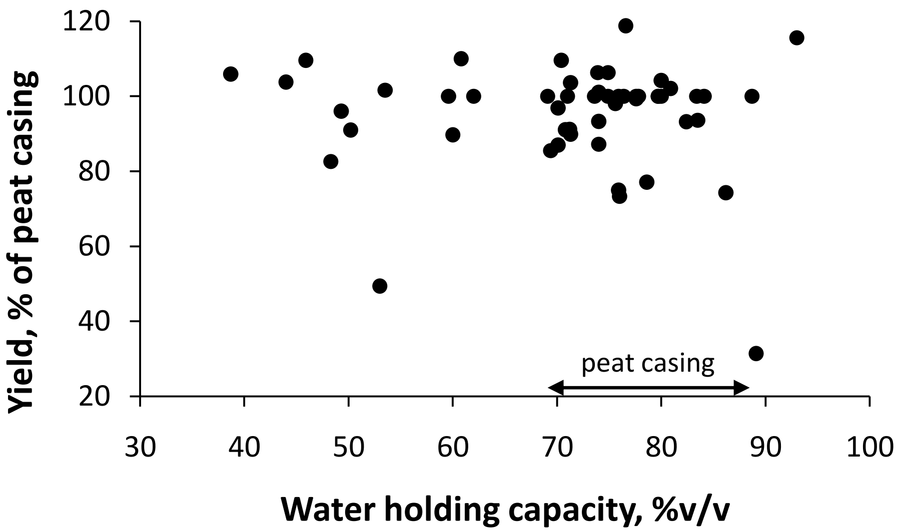

Figure 4. Water holding capacity of casing materials and mushroom yield expressed as a percentage of yield obtained from non-amended peat casing.The range in water holding capacities of peat-based casings is shown by the arrow.

Consultations with growing media companies and researchers

A research project examining the use of SMS in casing has recently been completed at University College Dublin. The main recent research activity in casing materials has been in Spain at the Centro de Investigacion, Experimentacion y Servicios delChampinon (CIES), Cuenca, and the Universidad de Castilla-La Mancha, Albacete. However, this work has been mainly on Spanish (soil-based) casings. There is currently no other research on peat substitution in casing in the UK, Ireland or the Netherlands.

The availability and environmental pressure on sources of wet deep-dug peat is greater than on some sources of dried milled peat. The transport cost of deep-dug peat is also greater than that of dried milled peat. Addition of materials to milled peat to produce the physical characteristics of wet deep-dug peats requires further development work.

Discussions with several growing media manufacturers have highlighted impact of Environment Agency Waste Legislation on utilisation of materials deemed to be a ‘waste’ as peat substitutes. The requirement for Waste Licences, and the associated red-tape, makes the utilisation ‘wastes’ non-viable as growing media components. Certain wastes materials are exempt from these rules: (a) imported wastes such as coir (b) wastes that are entirely marketed as a product such as sugar beet lime (c) materials that have PAS quality standard such as PAS 100 compost and PAS 110 digestate and (d) various materials that have exemptions such as horse manure. Some of the growing media companies contacted are in discussions with the Environment Agency on obtaining exemptions for using particular materials as peat substitutes. Separated spent casing could be recycled immediately within the same premises, avoiding Waste Licence requirements.

Conclusions

1. Overall, there was weak negative relationship between the proportion of peat substituted in casing and mushroom yield.
2. The most promising materials for peat substitution in the UK are recycled granulated rockwool and recycled spent casing.
3. Wood fibre and PAS 100 mature green waste compost are also potential materials but there is no information on using them at a low inclusion rates in peat-based casing.
4. By-products clays and silts can be used in casing; at inclusions rates below 20% v/v they can be considered to be sugar beet lime replacements but at higher inclusion rates, they can also substitute peat in casing.
5. SMS and anaerobic digestates, even after storage and leaching, are unsuitable casing ingredients, mainly due to high EC.
6. There was a weak negative relationship between casing EC and mushroom yield, although EC values of 1 mS/cm or less had no effect on yield. Overall, none of the

physical properties of the casing materials measured in the references were significantly correlated with mushroom yield.

7. There are currently no parameters for defining the properties of the best peat or peat substitute casings. Low EC (<1 mS/cm), high water holding capacity at a range of matric potentials and a defined bulk density are probably the most important criteria in selecting materials that may be suitable for use in casing but this requires further investigation.
8. Environmental pressure is greater on sources of wet deep-dug peat than on some sources of dry milled peat. Addition of materials to milled peat to produce the physical characteristics of wet deep-dug peats requires further development work.
9. Casing materials can have a large effect on mushroom quality, particularly cleanness, as well as whiteness.
10. There is some evidence that casing materials can differ in their suppressiveness to disease, specifically cap damage due to bacterial blotch and *Trichoderma*.
11. Waste License regulations are currently inhibiting the utilization of certain peat substitute materials such as clays and silts from mining.

Knowledge and Technology Transfer

HDC News 171 (2011) New projects. Peat replacement in mushroom casing. p7.

Glossary

EC Electrical conductivity

MRF Multi-roll filter cake, a clay-silt by-product of mining and aggregate production

SBL Sugar beet lime

SMS Spent mushroom substrate

References

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Appendix

Companies and researchers contacted in relation to peat substitution in casing

Chris Blok, Wageningen University, The Netherlands

Henry Breukers, CNC, The Netherlands

Dave Dobson, Fibregro, Pietermaritzburg, South Africa

Owen Doyle, Jason Barry, University College Dublin

Mairead Kilpatrick, AFBINI

Kim Harding, Cultilene, UK, The Netherlands

Stuart Lambie, Jill Coomans, Grodan, UK

Jim Smith, Shaun Cavanagh, Scotts, Cumbria

Ge Wijnands, Topterra, The Netherlands