MUSHROOMS IN IRELAND, AND THE WORK OF TEAGASC

By Dr Jenny Ekman

When people think of horticulture in Ireland, they probably think potatoes. However, the largest horticulture sector in Ireland is actually mushrooms. With 40 farms employing more than 3,500 people and a farm gate value over €120 million, mushrooms are a major industry on the Emerald Isle, a country with a population of only 5 million.

Yet despite gradual growth, the position of the mushroom industry is increasingly under threat. Labour shortages, complications due to Brexit (80% of production is exported to the UK), changes to local regulations, reduced funding for R&D and growing focus on environmental sustainability including carbon footprinting have increased challenges to mushroom growers.

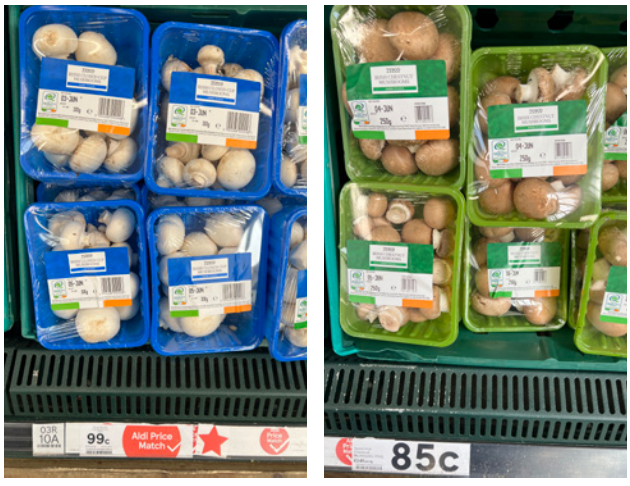

Figure 1. Irish mushrooms on retail display in Dublin. Prices are equivalent to A$4.90/kg (white) and A$5.04/kg (brown) respectively. Note the use of perforations in the plastic film to prevent condensation. Photo by Georgia Thomas.

Like Australia, the last few years has seen consolidation of the industry. Small farms have closed or been taken over, while larger operations continued to expand. The average farm size is now 12 grow rooms using 100 tonnes of substrate weekly. This is considered the minimum commercially viable farm size for white mushrooms, although brown mushroom growers can operate at half that size.

All are shelf farms as blocks and bags are no longer produced by composters.

During a recent trip to Ireland, I was lucky enough to spend a day with Dr Helen Grogan at the Teagasc Ashtown Research Centre, as well as meeting the "Beyond Peat" research team.

Teagasc and Dr Helen Grogan, leaders in mushroom R&D

Teagasc – pronounced "Chaggass", meaning "to teach or teaching" in Gaelic – is the Irish Agriculture and Food Development Authority. They do everything from research and advisory services to providing Agricultural education at degree and certificate level.

Figure 2. Dr Helen Grogan with the author, outside the mushroom research unit.

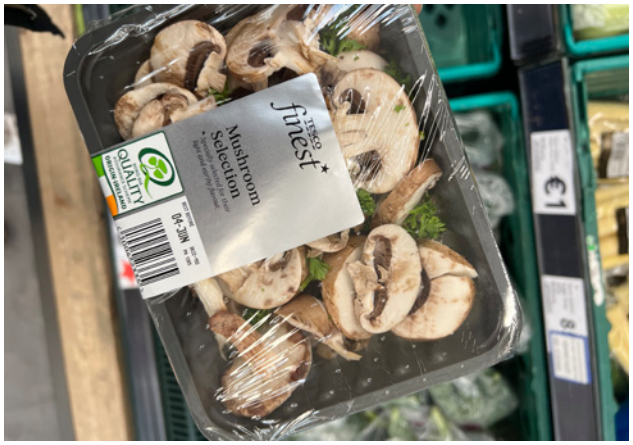

Figure 3. Irish mushrooms audited to the Bord Bia quality assurance certification scheme.

They work closely with Bord Bia (The Irish Food Board), which has an audited quality assurance scheme relating to both farming practices and food safety for local products (Figure 3).

Teagasc has been a leader in mushroom research and technology for many years. They run a multi-room mushroom unit at their site just outside Dublin (Figure 4), and provide advisory and training services for the local industry.

The research unit has facilitated much of Dr Helen Grogan's seminal work on mushroom diseases. Helen Grogan will be familiar to many in the Australian industry, having visited here several times and collaborated on a range of pest and disease projects.

A mycologist by trade, Helen has conducted extensive trials on every grower's nightmare – *Trichoderma aggressivum*. In fact, Helen still holds the record for the most webinar registrations (87!) when she presented on this issue for the Australian industry.

Defying the virus

We all certainly know a lot more about viruses now! Much of Dr Grogan's recent work has been focussed on managing these difficult organisms. Surprisingly, large numbers of different viruses are found in mushrooms. For example, research published in 2017[1] found 18 distinct viruses in *Agaricus bisporus* alone.

As viruses are carried within the mushroom mycelium, they can be transmitted in fragments of compost produced during crop filling or emptying. All compost

Figure 4. Inside the Teagasc mushroom research unit.

fragments must therefore be erradicted. The only control method is hygiene, particularly thorough cookout of compost as well as removal of all compost fragments on conveyors and surfaces by washing and disinfection.

Most viruses cause no symptoms. However, a few can have serious impacts on quality and yield. For example, the La France virus, first identified in 1962, can cause gradual loss of vigour and the appearance of bare patches. These are surrounded by mushrooms with brown and elongated stipes, small caps and waterlogged tissues.

Currently, the most important virus worldwide is AbV16 – one of the mushroom virus X (MVX) complex. In Ireland, MVX-AbV16 mainly causes brown or off-white mushroom caps. Although MVX viruses were recently identified in Australia, they do not appear to be causing major yield losses – yet.

Dr Grogan was previously involved in developing a rapid RT-PCR test for presence of MVX, as well as examining the effects on yield and quality[2]. According to Dr Grogan "Low rates of virus had little or no effect on yield. However, when there was a large amount of virus introduced at spawning, yield could be reduced by up to two thirds. Interestingly, in these trials, the effects on browning were most obvious for the first flush, being much less pronounced by the second." Unfortunately, lack of funding has now ended research in this important area.

In contrast, the Australian mushroom industry SIAP recently supported a recommendation for a funded PhD in mushroom virology specifically focussed on strains of Virus X. While the student would be based in Australia, it provides an opportunity for Dr Grogan to co-supervise, lending her expertise to building technical capacity in Australia. "I would be really pleased to be involved in a project of this kind," Helen says, "I'm looking forward to coming out to Australia in the near future, and this would potentially give me an opportunity to work with a new student on this challenging, but fascinating, topic."

Biological control of Bubble

One project in progress at Teagasc is comparing *Bacillus* based products with chemical control products like prochloraz for control of dry bubble disease. "The Bacillus struggles to control the disease if there is a heavy inoculum load, which is used to test chemical products," comments Helen. "However, we are investigating if they are more effective under lower disease pressure, which is probably more representative of the situation on mushroom farms.

"Biological control may be more effective if a number of products are combined, an aspect we are interested in working on. We are also interested in demonstrating just how effective the technique of 'salting' is at controlling the spread of disease. When done well, it can dramatically reduce disease levels".

Turning lignin into mushroom lunch

"One fascinating project we are working on is characterising the efficiency of lignin degradation by different *Agaricus bisporus* isolates. The aim is to find genes involved in the lignocellulose degradation pathway that are more or less effective in breaking down the substrate. This will shed light on the process and potentially identify factors that influence how *Agaricus* can access more of the nutrients available in the substrate."

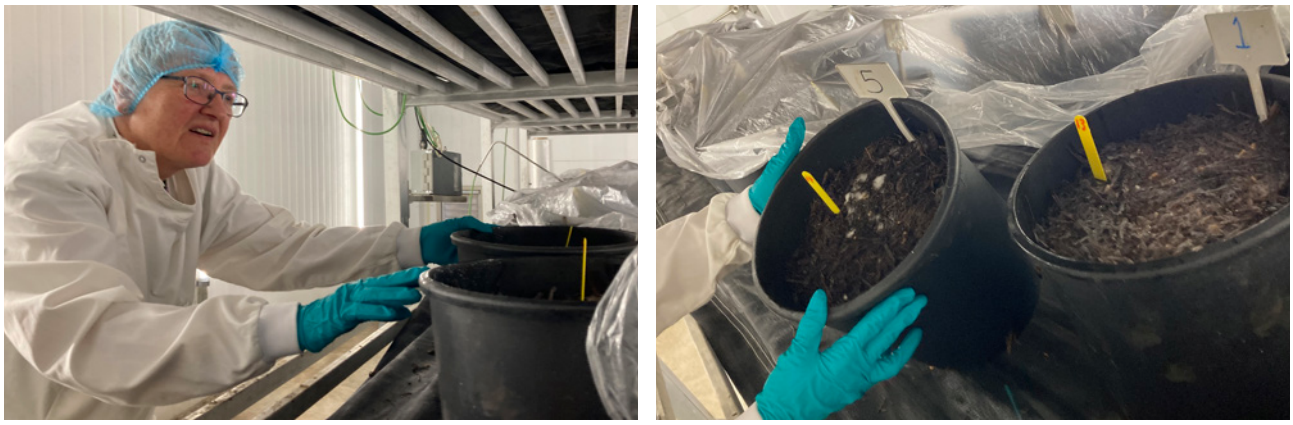

Figure 5. Dr Helen Grogan checks progress of a trial examining efficiency of lignin degradation by different *Agaricus* isolates

Figure 6. Gathering data on the forces required to harvest a mushroom (top) and prototype of a soft gripper for harvesting mushrooms robotically (bottom). *- Photos by H. Grogan*

The team is generating variants, growing them through the compost, then examining yield, substrate use, enzyme activity and gene expression. "Finding mushrooms that can degrade lignin more efficiently could potentially increase yield. At least, that is the long-term objective," explains Helen.

Robotic pickers

Finally, crops are in place to test a new robotic harvesting process. This is part of an EU-funded project 'SoftGrip' with six partners spread across the European Union. As both the cost and availability of labour is an issue – as it is here – the push is on to find better ways to automate mushroom production as well.

It is still early days, but the focus of the team is to develop a 3-pronged soft gripper using new, flexible materials. To test the machine, the mushrooms are being grown in 1 m^2 containers that fit the full width of the shelving, replicating commercial practice as closely as possible.

Beyond Peat

But the biggest mushroom related project underway at Teagasc is 'Beyond Peat', a five year project funded by the Irish Department of Agriculture, Food and the Marine (DAFM). Commercial harvesting of peat has been banned in Ireland since 2019. Although arguments are being formulated to facilitate a gradual transition away from peat use for horticulture, casing producers must seek out peat alternatives.

If suitable alternatives can be identified, peat will be phased out of all horticultural use by 2030. However, new regulations mean that all peat use will end by 2035 regardless – a deadline which is driving the concerted effort to find alternatives.

Of course, peat is not just used for mushroom casing. In fact, only 4% of Irish peat was used in horticulture, with the vast majority burned as fuel*. Peat is also used as a substrate for growing soft fruit and ornamentals, and within potting mixes.

According to project leader Dr Michael Gaffney "The key to finding a replacement for peat as casing is identifying a consistent supply of sustainable materials, and standardising the production method."

"We would prefer to use products that don't have other uses. For example, wood chips and forestry waste have potential, but are also used to generate energy, potentially making supply problematic. On the other hand, bi-products of industrial processes, such as biochar**, could work. However, the characteristics of biochar vary according to the feedstock used, so we really need to understand the critical factors that will give it the characteristics we need."

Other options include spent rockwool, hydrochar (produced from pig slurry) and even mixtures of plastics and organics. Coconut coir is not being considered, as it must be transported half-way around the world, making it less attractive as a sustainable alternative.

"Once we have identified some promising materials, we are aiming to conduct up to 15 commercial trials across a range of crops," comments Michael. "The aim is to have replacements for various purposes close to commercial production by 2025."

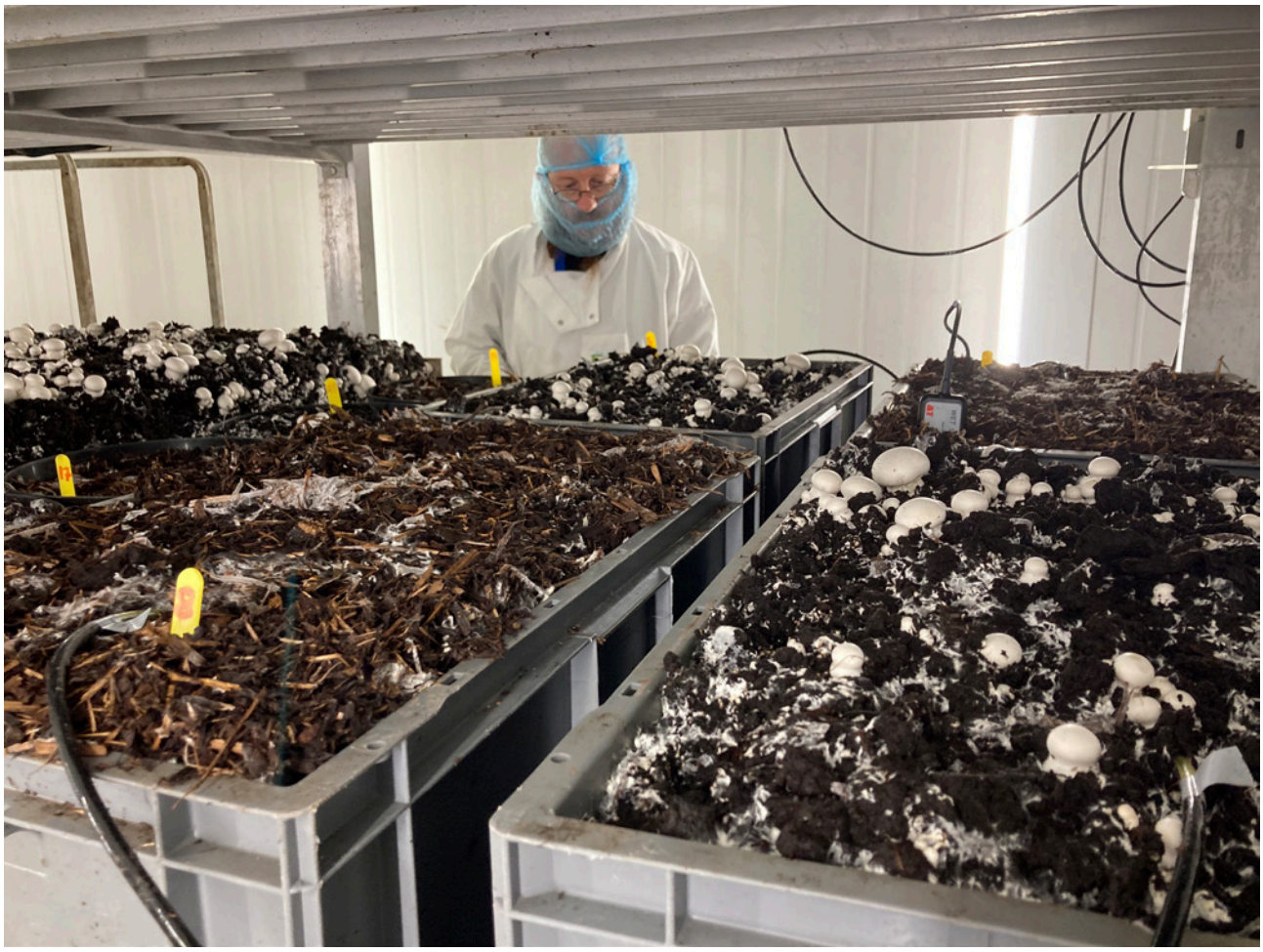

Figure 7. Initial casing trials at the Teagasc research facility

Between reduced or closed supply of peat from some countries, shipping disruptions, and now changes to inspection which slow entry processes, Australia could find itself with a similar problem with regards peat.

One of the ten new projects recently supported for funding by the SIAP through the mushroom industry levy (see mushroomlink.com.au – News) focusses on exactly this issue; developing a sustainable transition to alternate casing materials.

If approved, collaborating with our Irish colleagues would have many benefits. Even if we use different raw materials, using similar methods for assessing material characteristics, and finding the right combination, could lead to a peat replacement – or partial replacement – a lot faster. Essentially, a whole that is greater than the sum of its parts.

And I for one am happy to re-visit Ireland anytime!

* The cost of energy in Ireland has nearly doubled due to the war in Ukraine, and there are now calls for the ban on peat extraction to be at least temporarily removed.

** Biochar is produced through pyrolysis: slow burning of organic material in the absence of oxygen.

[1] Deakin G., et al. 2017. Multiple viral infections in Agaricus bisporus – Characterisation of 18 unique RNA viruses and 8 ORFans identified by deep sequencing. Scientific Reports. 7:2469.

[2] Fleming-Archibald C, Ruggiero A, Grogan HM. 2015. Brown mushroom symptom expression following infection of an Agaricus bisporus crop with MVX associated dsRNAs. Fungal Biology. 199:1237-1245.