Growing Oyster Mushrooms & More....

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Sustainable Living in the Suburbs

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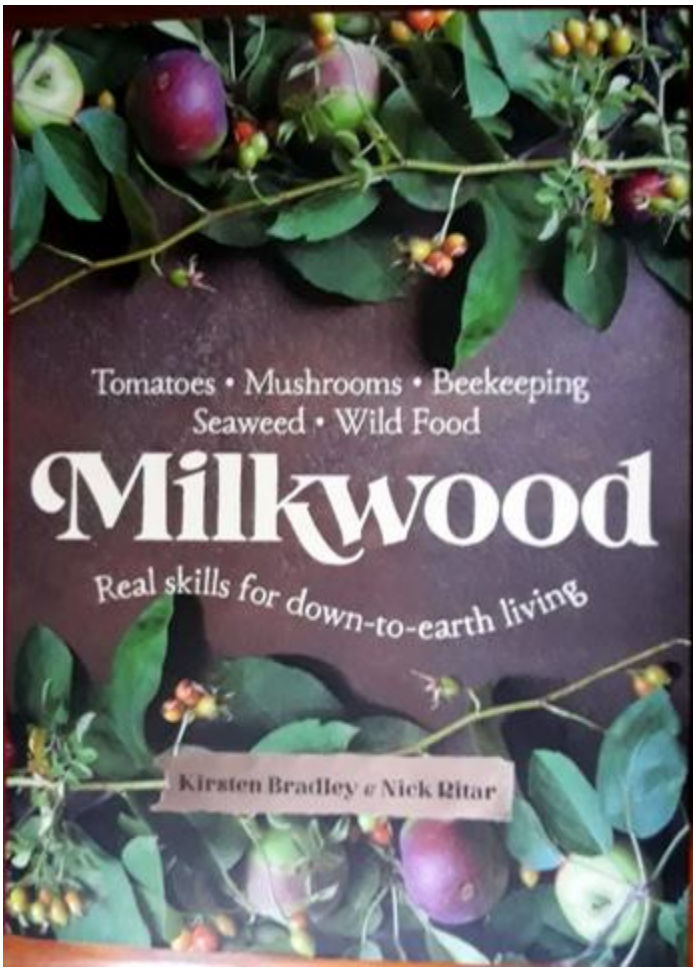
1.0 Introduction

I have been wanting to grow mushrooms here at the Choko Tree for years, and I have fooled around with various forms of commercial kits (and one from-scratch foray) without, I've gotta say, much success. My focus has been on the usual style of button (agaricus) mushrooms most readily available commercially, but reading has recently lead me to the idea that maybe I could grow white oyster mushrooms. We had never tried them, so Just to be sure, I bought some and we cooked them up and found them to be quite palatable, so why not?



The process which I am using is based up the method set out by Nick Ritar and Kirsten Bradley in their book **'Milkwood'.** The book gives lots of good theory and practical type information on mushroom growing using a number of different techniques and also covers stuff like beekeeping, wild food, seaweed and tomato growing. Before finding this book the stuff I had on mushroom cultivation was from overseas (the US and UK mainly) and while the theory doesn't change the mechanics and required bits and pieces will vary. Also climatic differences and species available will have an impact on how you grow mushrooms and these will vary depending on location. This is an Aussie book for Aussie conditions and that made lots of things easier.

1.1 Context

Mushrooms can be grown using commercially available kits or 'from scratch', indoors or outdoors and the species and set-ups will vary. While the most commonly available commercial species generally known as button mushrooms (agaricus bisporus) have been available in kit form for many years, other less familiar but just as tasty and nutritious mushroom species are also becoming available in kit form.

Likewise many suppliers of spawn, equipment and knowledge are now accessible through the internet and are able to provide all the requirements for growing both familiar and unfamiliar mushrooms indoors or outdoors from scratch.

1.2 Terminology

There are some terms in mushroom growing which I shall be using and just to make sure we are clear on what I am rabbiting on about, here are some definitions –
Mycelium/Mycelia: the vegetative part of the mushroom fungus consisting of a mass of branching white threads called hyphae.
Mushroom: the fruiting body of a mushroom fungus which produces spores, allowing the fungus to reproduce.
Spawn: a substance which has been treated with mushroom forming mycelium of a particular type. Spawn is most commonly supplied in the form of grain, hardwood plugs or sawdust but can also be supplied (less commonly) as straw spawn, woodchip spawn or a liquid slurry. In this case I was using grain spawn.
Substrate: the organic material which the mushrooms grow on. May be straw, hardwood logs, hardwood sawdust, paper or other materials. The substrate required will vary with the type of mushrooms grown. In this case I was using a mix of chopped straw and hardwood sawdust as my substrate.

1.3 Some Edible Mushroom Species

East to grow

- King Stropharia/red wine cap (stropharia rugosoannulata) – grows outdoors in woodchip gardens – Temperature range: 5 – 35°C; Preferred substrate: hardwood chips
- Oyster Mushroom (pleurotus ostreatis) – comes in a number of strains – grey, white, tan – Temperature range: 7 - 25°C although temperatures can vary depending on the strain; Preferred substrate: Will grow on most cellulosic substrates such as straw, hardwood sawdust, leaves, corncobs or paper
- Shiitake (lentinula edodes) – grown outdoors on logs - Temperature range 14 – 20°C; Preferred substrate: Hardwood logs
- Velvet Pioppini (agrocybe aegerita) – native to poplar wood - Temperature range 10 - 18°C; Preferred substrate: Hardwood sawdust

For more advanced growers

- Button mushroom (agaricus bisporus) – favourite commercial mushroom – Temperature range: 20 - 25°C; Preferred substrate: Manure & straw compost
- Enoki mushrooms (Flammulina velutipes) – Used in Japanese cooking. Temperature range: 8 - 12°C; Preferred substrate: hardwood sawdust
- King Oyster (large cap) – (pleurotus eryngii) – also has medicinal properties – Temperature range 10 - 21°C; Preferred substrate: wheat straw or hardwood sawdust.
- Morel – (morchella angusticeps) – prized by gourmet cooks, especially in French cuisine – Temperature Range: 13 to 15°C; Preferred substrate: Soil
- Turkey tail (trametes versicolor) – considered to have positive health impacts – Temperature Range: 8 - 23°C; Preferred substrate: Hardwood sawdust
- Yellow oyster mushroom (pleurotus citrinopileatus) – grows well with straw log bags – Temperature range: 21 - 29°C; Preferred substrate: will grow on most cellulosic substrates such as straw, hardwood sawdust, leaves, corncobs or paper.

2.0 Growing Oyster Mushrooms

2.1 Setting Up

To set up to grow oyster mushrooms using this process you are going to need a few things and some stuff.

Things

- Fruiting containers – in this case food grade buckets with a tight fitting lid, we find the 11 litre style supplied by the big green hardware store works for us.
- A half inch or 10 - 12mm twist drill bit, a quarter inch or 5 – 6mm twist drill bit and a hand drill of some description to drive them.
- A fruiting chamber (read small plastic greenhouse, more detail under 'Inducing Fruiting).
- Several large containers for use with pasteurising including 20 litre container and a 55 – 60 litre container or two.
- A method of heating 40 litres of water (more details on this in the pasteurising section)
- A thermometer that will read to 80^{o}C or greater.
- PPE – Dust mask (P1), safety glasses or goggles and gloves (Eg PVC or nitrile washing up gloves).

Stuff

- Micropore tape (try your local chemist)
- Substrate (hardwood sawdust, chopped straw, slaked lime)
- Mushroom spawn of the correct species.

Micropore Tape

Preparing the Containers

To prepare the fruiting containers (Plastic buckets) used to hold the mix of substrate and spawn that will eventually produce the mushrooms, you need to drill holes in the side. This is to allow gas exchange initially and then later on these will be the holes from which the fruiting bodies (oyster mushrooms) will emerge for harvest.

Marked out and pilot hole drilled

I have found it easiest to drill a 6mm pilot hole first, as this prevents the larger 12mm twist bit wandering around before biting in and drilling the hole. I drilled two lines of 6 holes each 150mm apart in the line with one line 50mm down from top and the other 50mm up from bottom. The two lines of holes were offset from each other by ½ rotation (see photo). I marked them out with a tape measure and marker pen prior to drilling.

Main hole drilled and being deburred

Once the holes are drilled, the idea is to place some of the micropore tape over each of the holes. Due to the tapes construction, it allows gas exchange, but keeps out spores of mushrooms present in the air which would compete with the species we are trying to grow. Thus air can get in and CO2 can get out without compromising the integrity of the

inoculated substrate. To ensure the tape fits well it may be necessary to 'deburr' the holes with a sharp knife to remove any plastic burrs remaining on the edge of the holes prior to applying the tape.

main hole cleaned up and taped

Job done!

2.2 Mixing, Pasteurising and inoculating the substrate

This was the most technical and time consuming operation of the whole growing process and to produce enough material to fill three by 11 litre buckets took us the greater part of a day.

2.2.1 Mixing and hydrating the substrate

For this process you need about 30 litres of substrate. The recommended substrate from the book is one third chopped straw (I believe 100mm is the usual straw length of chopped straw) to two thirds hardwood sawdust, although I have been told that the exact proportions are not critical and there is some flexibility here so don't get too uptight about it.

For us the straw was relatively easy as we keep it for the chooks, but the hardwood sawdust was a bit more problematic. This is going to be used to grow stuff we were going to eat and so needed to be sources in the same way you would soil to grow veggies in, it needed to be hardwood, not softwood and no pressure treated (CCA) sawdust. Also, I am cheap and my first thought was to get some for free from wood machinists/saw mill somewhere. This proved to be more difficult than I thought and the only stuff I could source which seemed able to do the job came in one metre cubed bulkabags. OK, they were free but would be difficult to transport (it was pick-up only) and store.

I had just about shelved the mushroom plan for lack of substrate when a mate shouted me a 75 litre bag of hardwood sawdust from a butcher's supply place. While it did not cost too much for the bag, the cost of delivery from Melbourne more than doubled the total cost of the material. So a shout out to John for his generosity!

When looking at substrates for your mushroom projects I think Nick's words should be borne in mind – "There are many options for container substrate, and it's important for the long term resilience of your mushrooms that you choose a source that is locally available, preferably a waste product" (Milkwood Page 81). Fortunately, with a ready supply of sawdust provided for me, I can start experimenting now while I research local sources.

2.2.2 Preparing the Substrate for Pasteurising

Note: builders lime is an irritant so when handling it you should wear the dust mask, gloves and eye protection.

To prepare the substrate it needs to be mixed, limed and hydrated. To do this I measured out a full 10 litre bucket of straw and a full 20 litre bucket of the hardwood sawdust into a 60 litre plastic tub. I then weighed out 250grams of hydrated or slaked lime, also called builders lime. I got the lime from the green hardware but because it was builders lime not garden lime (Calcium hydroxide vs calcium carbonate) the only bag I could get was 20kg. I have enough lime for mushroom growing for the next 100 years!

With the solid materials in the tub I gave them an initial mix and then started to add water. It is important to add the water slowly because you need to add enough to moisten the entire batch of substrate but not wind up with a soupy mess! The way I did

this was to add water in small increments, then mix, and repeat. The whole mass of substrate needs to be moistened to allow the heat to penetrate during the pasteurisation process, otherwise there may be pockets of unpasteurised substrate which can contaminate the whole lot once the substrate is inoculated and left for the mycelium to run.

All in the bucket

After water and mixing

2.2.3 Pasteurising the Substrate

The substrate has been formulated to be ideal for growing fungi, but the idea is to prevent as much as possible other fungi from colonising it so we can grow the species of fungi we want, in this case oyster mushrooms. For the substrate to be pasteurised it needs to be kept at a temperature above 60^{o}C for in excess of two hours by soaking it in hot water. To contain the substrate while this is happening it gets placed in cotton pillowcases, in this case three pillowcases with 10 litres of substrate per pillowcase.

Heating the water

To pasteurise 30 litres of substrate we needed about 40 litres of fresh water heated to 80^{o}C, and this proved to be one of the most problematic parts of the whole process. One of the hints is to use an electric urn, which is what I intended to do because after holding some workshops at our place we had picked one up so we could provide tea and coffee easily when required, and then filed that issue as sorted. Unfortunately, as the day grew closer I realised that the volume of the urn was 10 litres so I had to find another 30 litres of hot water from somewhere.

I had intended to start off with water from the solar hot water so at least I was not starting with dead cold water, but true to form, the days leading up to 'mushroom day' were cold. Rainy and sunless, leaving only tepid water in the hot water system. Yes I

could have turned on the electric boost but that kind of defeated the purpose of using the solar.

I finally decided to use the urn, but to also heat the remaining 30 litres water I needed in a steel 50 litre drum I had, perched atop my rocket stove. That way I could use sticks and stuff I had gathered from the local park to heat the water. I had tried a similar stunt with a vacola bottling kit years ago, and it took forever and didn't get much above 60°C due to (what I assumed to be) loss of heat through the sides. To reduce this I grabbed a spare glass fibre insulation batt, wrapped it around the sides of the drum and taped it on. It covered the majority of the sides so hopefully it would work!

The water started out at a balmy 15°C and while the rocket stove was starting out I filled and set the urn going. I set the 50 litre drum up and then slowly put 30 litres of water in it. It took a while but after half an hour the water was 25°C and the urn had boiled and been turned off. The my sweetie came up with the classic idea – take 10 litres out of the drum and put in the contents of the urn! Winner!

So I did that and refilled the urn and turned it on to reheat, the water in the 50 litre drum was now at 50°C and heating steadily, the insulation seemed to be doing its job. After about an hour the 50 litre drum was just over the 80°C mark and the urn had long since boiled and was keeping hot – we had hot water!

As a vessel to hold the substrate filled pillowcases I intended to use a cleaned out 55 litre plastic garbage bin I had been using as a storage container. When I put the pillowcases in I was a bit concerned at how much space they took up, would all the water fit? I moved the garbage can to where I had the rocket stove set up (I was NOT going to juggle 30 litres of hot water!) and placed it inside the 60 litre plastic tub. I did this for three reasons –

1. It was a cold day and I wanted to see if the airspace between the garbage can and the side of the tub would act as an insulator to reduce energy loss,
2. I was not totally sure about the structural integrity of the plastic garbage bin as it would have to have been at least 10 years old and if it sprung a leak the tub would contain it and hold it close to the substrate pillowcases, maybe allowing me to continue pasteurisation, and
3. If all the water did not fit in the garbage can I would pour it into the tub so its heat could still contribute to the pasteurisation process.

I have a plastic dipper I use when topping up the batteries and I used that to transfer the water from the drum and the urn into the garbage bin as quickly as I could and in the end, I was able to fit all the water in except for the last 2 or 3 litres, which dutifully went into the tub. I placed the lid onto the garbage can and then placed on top a couple of bean bag bean filled pillowcases I use as insulation in our stored heat cooker. This would hopefully keep the water in the pasteurising set up from falling below 60^{o}C for two hours. Then, as Nick Ritar suggests, I had lunch!

After a nervous wait of two hours I removed the insulation cushions and the lid of the garbage tin and measured the water temperature, it was 68^{o}C, we had pasteurisation!

2.2.4 Inoculating the Substrate

The next trick was to remove the soaking wet and still very hot substrate filled pillowcases, so I put the plastic washing up gloves on and washed my hands because cleanliness is important in preventing contamination. I pulled them out and squeezed them to remove as much excess water as I could and hung them up on hooks I had built in to the roof of the back deck to drain. I needed to move quickly to inoculate the substrate so I let them drain for 12 minutes only.

I set up a portable table in the back yard and wiped it over with vinegar as a disinfectant and left it to sit and retrieved the pillowcases. I had removed the gloves by this stage and washed my hands thoroughly. I emptied the substrate out onto the table, it had cooled to the point where it only felt a bit warm to my hands. I spread it out so that it make a layer 75mm to 100mm thick.

I retrieved the spawn from the fridge and opened the pack and broke off chunks, crushing them up and distributing them over the surface of the substrate, then spent about 10 minutes mixing the spawn and substrate thoroughly together. When that was accomplished I packed the inoculated substrate into the fruiting containers and affixed the lids.

It's winter here so I took the filled containers inside and placed them under our dining room table, so they would be somewhat warmer than storing them outside or in the garage or shed. It was then a 3 week wait to see how things had gone!

3.0 Inducing Fruiting and Harvesting

The theory was –

Leave the buckets full of inoculated substrate in a warmish space with stable temperature and I chose under our dining room table and leave them for three weeks. After the three weeks had elapsed, remove the lids and check to see if the spawn had run properly and the substrate was properly coated with mycelium. If the mycelium had run, move to the next stage, if not, replace the lids and put them back, check in a few days.

Assuming the mycelium run was good, fill the buckets with cool, clean water and leave them for 12 hours, I was going to leave them overnight, to stimulate fruiting. Drain and place them in the fruiting cabinet (small greenhouse) to maintain humidity and watch to see when fruiting occurs. You don't need to remove the micropore tape, the mushrooms will push it to the side and break out as they need to.

What really happened –

I pulled the buckets out and all of them had really good spawn run and were chockers with the stuff. But one bucket already had mushrooms busting out from half of the holes, the second bucket had mushrooms bursting out from one hole, and only just bursting out at that. The third bucket had no mushies bursting out at all!

Now this was a good thing and a bad thing, it was good because it showed I had the process right, but it also meant that I should have been keeping a better eye out on what was going on! The oyster mushrooms which emerged while the buckets were under the table never really got any bigger, and the best I can make out of that is that the humidity is was too low. Now that they are in the fru1ting chamber, new sprouts of mushrooms are emerging.

The idea with the fruiting chamber is that it keeps the whole set up in high humidity, but you also need to maintain airflow. We had mushrooms protruding from most of the holes in all three containers within a week or two, but it did seem to be a bit of a struggle to keep the moisture up using my go to technique – regular spritzing with a hand powered water spray. I made sure the fruiting chamber was in an obvious place which I would walk past regularly, but when things got busy I would forget (being old probably didn't help either!) and I think the humidity would drop, resulting in weird mushrooms.

Fruiting Chamber

I think the best thing would be to invest in an automatic mister (available online). Some small greenhouses I have seen advertised already come with an automatic mister and so if I was buying a greenhouse for use as a fruiting chamber again, I would get one with an automatic mister fitted.

There has also been another blessing in disguise! In my naivety I assumed that there would have been a uniform eruption of the mushrooms. If that had been the case, ie mushroom bursting out of all the holes, in all the buckets. All at the same time, I would have been up to my armpits in oyster mushrooms, so: mushroom soup, mushroom salad, mushroom pasta, mushroom ice cream – I'm sure you get the picture. In the event though, the harvest of mushrooms has been spread out over a couple of weeks rather than all at once! (thank heaven!).

Mushroom buckets in the fruiting chamber

In the end we got quite a few mushrooms but they mostly tended to be small and some came out very spindly, as a result of the inconsistent humidity. What we did get was very palatable and I included them in dishes I was cooking at the time.

The Adventure Conitnues!

4.0 Pillowcases, Second Flush and Lessons Learned

The first time I pasteurised a load of substrate, I was left with some pretty unpleasant looking pillow cases once they had been filled with sawdust and straw and stuck in hot water for two hours! Clearly, others had gone before me and would know the secrets of how to revive them, so I contacted my mushroom guru and asked how he cleaned them. His answer, elegant in its simplicity was: “I don’t!”

The pillowcases - since re-used

It turns out he had evolved past using pillow cases and now used nylon brewers' bags which are much easier to clean and reuse. This left me in somewhat of a quandary, but I am nothing if not stubborn! I dumped the pillowcases into a trug of clean water and sloshed them around to remove as much particulate material as I could, then turned them inside out and hung them on the line. Once any remaining particles dried off they were easy to remove by shaking the pillowcases. After that it was just a case of running them through the washing machine with a load of washing and they came out ready to go again, if not looking totally pristine.

4.1 The Second Flush

After the first flush of mushrooms from the containers, I removed the remains of the previous flush, re-applied the tape and then returned the buckets to the fruiting chamber and continued spraying with water regularly. The mycelium was still growing rampantly through the buckets and I held out great hopes.

After a couple of weeks there was no response so I tried the water soak overnight, but still there was no response and after a couple of weeks more I came up with a new idea which I am still investigating. But there was no second flush from that set of containers.

What the second flush looked like

4.2 Lessons Learned

As always with this stuff there are lessons to be learned and from comments on my posts and my own research, I believe the lack of fruiting and other mushroom issues can be put down to –

1. not enough ventilation in the fruiting chamber allowing an accumulation of carbon dioxide, and/or
2. lack of humidity in the fruiting chamber, the spraying I was doing just wasn't enough. Another suggestion which came up (thanks Bart Acres) was rather than leave a space at the top of the bucket, fill the buckets up to the top leaving no air gap. This will encourage more and better flushes.

I have a couple of ideas that I am currently working on which I hope will remedy the above issues and in doing so provide more better-quality mushrooms. I'll report on those as the results come in. Stay tuned!

5.0 The Next Generation

5.1 Fixing the problems

Previously, I recorded that I had concluded that my yields were not good because –

1. There was not enough ventilation in the fruiting chamber allowing an accumulation of carbon dioxide, and/or
2. There was a lack of humidity in the fruiting chamber, spraying water with the hand sprayer every so often just wasn't enough.

So, I did some research to see what I could do to rectify these problems and it turns out that there is a comparatively easy fix for both.

- For the lack of ventilation, I used a 12mm hole punch to make a series of holes in the top and sides of the fruiting chamber (ie small plastic greenhouse) to allow more ventilation/gas exchange. Then to restrict the entry of unwanted fungal spores I covered the holes with micropore tape, thus letting the air in but keeping the spores out.

- For the lack of humidity issue I got hold of fogger/mist maker of the type used in small indoor water features. I bought it off Ebay for the vast sum of $20 including postage.

You plug it in and immerse it in a water supply and it uses ultrasonic waves to create a mist which raises the humidity in the fruiting chamber. I set mine up on the top shelf of the chamber in a cat litter tray which I fill with water as the reservoir. My idea was the water vapour would be generated and then flow down over the mushroom fruiting containers and it does seem to operate like that.

So did it work? Well, therein hangs a tale –

5.2 Changing the paradigm

One of the problems I have had conceptually with setting up a system to grow mushrooms has been that I thought I needed to treat them like veggies. In other words, buy the seed (spawn) sow and raise seedling and pot them on (make, sterilise and inoculate the substrate) plant them out and grow them on (fill the fruiting containers and place them in the fruiting chamber) then look after them until they fruited. Maybe get two or three flushes then tip the spent containers out into the compost or veggie patch. This approach means buying more grain spawn each time I want to grow mushrooms and that gets expensive. (I don't have the gear, knowledge or skill to make my own grain spawn).

But mushrooms are not veggies, in fact they are not plants at all!

So, is there a way I can use so that I don't have to buy new spawn every time I want to grow mushrooms? It turns out there several, and this is my experience with the one I came up with.

After attending an online mushroom talk run by a friend of mine with Permaculture Sydney West it dawned on me that spawn is a way of distributing fresh mushroom mycelium evenly throughout the substrate to allow it to run and colonise the substrate. But what if you got mycelium from another source, mixed it through the substrate and allowed it colonise it in a similar manner to the grain spawn?

My thought was could I take the mycelium from a bucket which had already produced mushrooms and then use it in a similar manner to grain spawn? From some limited online research and reading through my books I didn't find any details about how to do it or even that you could. However, I also saw nothing that suggested it wouldn't work, so I figured the easiest thing would be to give it a go!

I made up and pasteurised some substrate as I had for the original three buckets then once I had this new substrate laid out on the table I took the mycelium/substrate mix from one of the original buckets, broke it all up with my hands then distributed it throughout the warm, freshly pasteurised new substrate. The other two buckets I emptied into the garden and then washed out the buckets.

I packed the new substrate/mycelium mix into all three of the now cleaned out original buckets and applied fresh micropore tape to each of the fruiting holes, closed them up and then placed them under the dining room table (as I did with the originals) for the mycelium to run through the substrate in a relatively temperature stable area.

I kept an eye on the buckets, opening them up once a week or so to see how they were tracking and indeed the mycelium was running through the substrate pretty well. The problem was that after about 6 weeks and a really good mycelium run they were showing absolutely no inclination to fruit. Clearly it was time to get serious!

I soaked one bucket in cold water overnight, then placed it in the 'new and improved' fruiting chamber (which I had installed in the garage) and a week later soaked the second one overnight and added it to the fruiting chamber. I kept an eye on them for another five or six weeks and not much happened. There was also no change in the remaining bucket under the dining room table.

When I say not much happened, one hole on one bucket did start to produce some oyster mushrooms, but in accordance with Murphy's Law, the reservoir (cat litter tray) ran out of water just as that was happening, allowing the fruiting chamber to dry out and the mushrooms never came to much. I had another talk with a friend who is a mushroom expert and after much consideration we decided that while I had been doing the right things, the original spawn I used was for a winter strain and maybe that was why I wasn't getting any fruit. It was summer after all, even if it had been a comparatively cool and damp summer.

I kind of lost interest at this point and transferred the last remaining bucket from under the dining room table into the fruiting chamber without bothering to soak it overnight. I did keep the fogger reservoir topped up just in case SOMETHING happened. And sure enough it did!

Some weeks later I was searching around the garage and noticed some large, white protuberances emerging from the side of the third bucket! Low and behold, we have oyster mushrooms! I quickly removed the bucket, harvested the mushrooms and transferred them to a container in the fridge and returned the bucket to the fruiting chamber. This process continued for a number of weeks with small flushes from, in the end, all three of the buckets.

From my playing around it does seem that the idea works, at least for one more generation. How long it will continue for I have no idea, because in my continuing research I have found out about the concept of strain senescence.

5.3 Strain Senescence

The term strain senescence when applied to mushrooms means that, over time as the cultures divide and age, genetic errors can creep in, changing their original vigour and vitality. This results in less mushrooms and smaller mushrooms even on the first flush of the next run. When that happens it is time to get rid the mycelium currently in use and buy more spawn, but I have no idea how long that takes, but from what I have read maybe five to six generations out. I will just have to see!
Either way it is a means of getting more mushrooms from your original investment in mushroom spawn so it seems to me it is worth considering.

6.0 Making a Fruiting Chamber

My researches in trying to get the best harvest I could out of my mushroom growing efforts led me to the idea of a fruiting chamber. This is a structure that keeps the atmosphere surrounding the mushrooms high in humidity, while still allowing sufficient airflow so that carbon dioxide generated by the mushrooms can escape. Both low humidity and carbon dioxide build up and interfere with mushrooms fruiting.

People have made DIY fruiting chambers from many things, including: old modified fridges, shower screens or windows constructed to make a cabinet, or a plastic tub (or tote) with holes drilled in it. (called a 'shotgun' fruiting chamber). One of the more popular ones, and the design I chose, was to use a small plastic greenhouse, and by small I mean the 580mm wide x 380mm deep x 1280mm high model readily available in hardware stores, nurseries or online.

Initially I set it up inside the house, in our lounge room to keep it a bit warmer and relatively temperature stable. Also, seeing as it needed to be sprayed with water using a spray bottle regularly, I wanted it to be somewhere I could see it and go, "that's right, I have to keep that thing damp!"

In its original form (just the greenhouse by itself) the fruiting chamber worked, but not very well and my sporadic spraying of water from the spray bottle didn't help, it just didn't keep the fruiting chamber humid enough, resulting in stunted mushies. There was also the other issue, on further research it seemed likely that due to the fact that the mushroom containers were fully enclosed to keep the humidity in, it also kept the CO_2 in, which also results in stunted mushies!

I needed a two pronged approach to make my fruiting chamber work better. The continual (and ineffectual) spraying I was doing got old pretty quickly and so I needed to get something of a more automatic type that could keep the chamber humidity high, thus removing the need for continual intervention by me!

I got hold of a fogger/mist maker of the type used in small indoor water features, you know, the ones with a fountain that is shrouded in mist for a calming effect. You plug the fogger in and immerse it in a water supply, it uses ultrasonic waves to create a mist which then rolls out over the fountains landscape.

I bought one off Ebay for the vast sum of $20 including postage, I set it up on the top shelf of the chamber in a cat litter tray which I then fill with water to act as the reservoir. My idea was the water vapour would be generated and then flow down over the sides of the cat litter tray to the mushroom fruiting containers below, and that is in fact what happened.

To install it I punched a 12mm hole through the side of the greenhouse/fruiting chamber (see below) and then unplugged the fogger from the plug in transformer lead. I placed the fogger itself into the cat litter tray, ran the lead through the hole and reconnected it to the supply lead, then plugged in the transformer. I then used a bit of the micropore tape to seal the hole through which the supply lead ran. I turned it on, the result? Fog!

Next, to improve the ability of the system to remove CO2 without also removing the humidity, I hit on the idea of using a 12mm hole punch to make holes in the top and sides of the fruiting chamber and then covering the holes with micropore tape. The tape allows gas exchange while retaining the water mist inside and keeping any unwanted wild fungal spores outside. That was the theory I was operating under and it seems to have been successful.

Next, I needed a place to set up the fruiting chamber for full time use, and sitting it in the lounge room wasn't going to cut it. All of that humidity is great for the mushrooms but there can be considerable condensation on the floor as a result. I have read that some people put theirs in the bathroom, for consistency of temperature (and the tiled floor would not be wrecked by the condensation) but our bathroom is too small for that so I elected to put it in the garage. The garage has a concrete floor but it does get a bit colder than I or the mushrooms would like but overall it seems to work very well except perhaps, in the depths of winter.

To use the chamber, just put your mushroom boxes, tubs, bags or whatever containing the spawn and substrate into the fruiting chamber shelves below the fogger and water reservoir, turn on the fogger and then zip up the front of the greenhouse/fruiting chamber and away you go. Keep a check on things every few days at least, so you can top up the water reservoir as required and see if fruiting has started. Some mushrooms will progress quite quickly so you need to keep an eye on them daily once they start to emerge and harvest them when they reach the stage you want.

So far I have found the fruiting chamber to work very well and, all things being equal, allow me to get a much better harvest from commercial kits and DIY mushroom growing set ups too. It was cheap to put together but it is remarkably effective, so if you want to grow your own mushrooms I would suggest putting one together.

7.0 Growing Mushrooms using commercially available kits

I have had variable results when using commercial mushroom boxes/kits over the years, trying to coerce a crop out of something which does not want to be forthcoming. Certainly part of the problem has been my lack of understanding of the process of mushroom fruiting and this has prevented me from providing the correct environment for fruiting to occur.

That, and some of the boxes have just been utter crap!

But, growing mushrooms with a kit can be easy, fun and productive once you know how to do it and has little in the way of up-front costs, just the kit itself and a few small one-off purchases to help along the way. The requirement for growing each mushroom type will vary and details for two types are provided below: the common and very popular button mushroom and the less well known but easy to grow oyster mushroom.

7.1 Button mushroom (Agaricus bisporus)

Button mushrooms will fruit and grow at the open top of the kit.
The kit will usually come as a corrugated cardboard box with a plastic bag inside containing the substrate and mycelium, there will also be a smaller plastic bag within the main one containing the casing material. Open the box, and the inner plastic bag, remove the smaller bag of casing material and inspect the substrate, it should be covered in white thread like material called mycelia or mycelium. If the compost substrate looks brown the mycelium run has not been completed, reclose the plastic bag, shut up the box and leave it for a week. Upon re-opening the box, the mycelium run should be showing up as white thread-like material, if not close up and wait another week.

Casing applied

Once the mycelium has run and it ready for the casing material, fold the opening of the box down onto the sides and then run the inner plastic bag down so that it keeps the cardboard flaps down against the side of the box. Then fluff up the mycelium containing substrate and even out the top, so it is level, then open the bag of cocopeat 'casing' and spread it evenly over the top of the substrate and mycelium. Give the casing a fine spray with water to ensure it is damp. The kit is now ready to go.

Place the kit in a low light area (not necessarily dark) that will maintain a temperature of 20 to 25° C and a high humidity. Humidity can be maintained by regularly misting the top of the casing a few times a day, but the best way is to put together a fruiting chamber. The fruiting chamber (See previous chapter) will ensure the mushroom kit stays in a moist but well-ventilated environment.

Comin' up!

They're up!

Fruiting should occur in three weeks or so, although this could take longer at colder temperatures. Fruiting starts with pinning, or the appearance of small white dots or 'pinheads' coming through the casing. Each pin head will develop into a mushroom. Mushrooms should be harvested by twisting them out of the substrate/casing. They can be harvested at the 'button' stage, where the cap is still attached to the stem, the 'cup' stage where the cap has detached from the stem but has not flattened out and the fully mature 'flat' stage where the cap has flattened out. The flavour of the mushroom becomes stronger and more 'meaty' the later the stage at which they are picked.

Flat, cup and button

Once the first 'flush' of mushrooms has been harvested, leave the kit in the fruiting chamber and it may produce several more flushes. The kit will continue to produce mushroom flushes until all of the nutrients are used up, after which the contents of the kit can be added to a compost pile or placed directly onto the garden.

7.2 Oyster mushroom (Pleurotus ostreatus)

Oyster mushrooms may fruit and grow from the side of the kit or the top. Depending on the maker of the kit, you may be required to set up using the outer box and the inner plastic bag, or just using the inner plastic bag. Before starting, ensure the mycelium has run through the substrate block to the point where it is predominantly white. If the block is not predominantly white leave it and check in a week.

Once the mycelium run is complete, open the box and remove the inner plastic bag full of substrate and mycelia. Cut a slit in the top of the bag or remove the top just below where it is sealed, fill the bag with cold clean water and allow it to soak for 24 hours. Once the 24 hours has elapsed, empty the bag. This is done to stimulate the mycelium to fruit, producing mushrooms.

If there appears to be a 'skin' on the surface, scratch it to expose the mycelium underneath. Either leave the top of the bag open or cut a flap in the long side with a sharp knife, but don't remove it. Some kits may require to cut out a 50mm x 50mm hole in the side of the box, replacing the bag in the box and then cutting an X in the plastic bag through the hole in the box, to expose the mycelium. The kit is now set up.

Plentiful harvest

Keep the kit in an area which gets at least 6 hrs of light (either artificial or indirect sunlight) per day, within its preferred temperature range of 7°C and 25°C and preferably in an environment of 70% humidity. This can be facilitated by misting with a hand sprayer with cool boiled of filtered water 2 – 3 times per day or placing the block in fruiting chamber as mentioned above.

Check the block regularly. Mushrooms may start to appear within 7 to 10 days. Harvest then when they reach 7 to 10cm in diameter cut them from the base with a clean sharp knife and they will be ready to eat. Rest the block for a week, then recommence misting and more flushes of the mushrooms will occur.

7.3 Mushroom kit troubleshooting

No mushrooms –

1. **Too dry or too wet** – The substrate in the kit needs to be kept moist but not soaking wet, it should release a few drops of water when squeezed between the fingers. Checking on the kit regularly and misting as required should keep the moisture in the ideal range, but it is easier with a fruiting chamber.
2. **No air exchange** – ensure the kit is stored in an area where there is adequate ventilation to allow carbon dioxide out and oxygen in.
3. **Wrong temperature** – A temperature lower than the optimum range for the mushroom can slow the growing process down and too high a temperature can stop the process entirely and even killing the mycelium. Ensure the area where your mushrooms are growing is maintained within the optimum range for that type of mushroom.

4. **Impatience** – these thing take time so be patient when things are not happening as quickly as you would like.
5. **A dud kit** – occasionally kits can be stored wrongly by the retailer or be too old when they were bought resulting in zero mushrooms. Buying fresh kits from a reputable supplier will prevent this happening again.

Oher issues

1. Fine powdery material around the kit when the mushrooms have fruited – these are mushroom spores and can just be wiped off with a damp cloth.
2. Flies around the kit – they are attracted by the compost, spread olive oil around the lip of the kit, the flies will get stuck to it and dry out.
3. Stunted spindly mushrooms that are all stalk and no cap – build-up of carbon dioxide due to poor ventilation, improve the ventilation.

Setting up and using a commercial kit is a great way to get into mushroom growing. Fun and educational for the whole family it is worth the small investment in money and time – and in the end you get mushrooms!

8.0 Resources

Mushroom Growing Today – F. C. Atkins – Faber and Faber Ltd (UK) 1966 ISBN 9781111111113 – This is (needless to say) and old book and focuses on how to start a mushroom farm back in the 60s. Lots of good information but not the only book a backyard grower should have in their library. The book goes through production of the standard (Agaricus) mushroom in considerable detail, with a section on pests and diseases which is certainly NOT organic (DDT anyone?). The section on "Other Aspects" of mushroom growing is slanted towards commercial production, talking about economics, but also abnormalities seen in mushrooms. The very last few pages talk about mushrooms for the "country gentlemen" and the amateur gardener. Some B & W photos and a few line drawings.

Mushroom Growing for Everyone – Roy Genders – Faber and Faber Ltd (UK) 1982 ISBN 0 571 11806 2 – While being and old and not organic in the slightest book, this one is better suited to small scale production of agaricus mushrooms. It talks about setting up, obtaining raw materials, composting, making the beds, spawning and casing, growing mushrooms outside and pests, diseases and their control. I am not sure how the pests and diseases from this UK book would relate to AUS mushroom production. No illustrations.

The Mushroom Cultivator – Paul Stamets & J. S. Chilton – Agaricon Press (US) 1983 ISBN 978 0 9610798 0 2 – This immensely detailed book is a mine of information for anyone who wants to get into growing their own mushrooms, and Paul Stamets is the mushroom guru. I have tried to read this one cover to cover but I find it too technical and information dense for an amateur like me. It is a great reference book and well worth having on the shelf if you are serious about getting into mushroom production. It covers a wide range of fungi including lots I have never heard of and even includes how produce your own spawn. Lots of B & W photos, some line drawings and a colour photo section.

Mycelium Running – Paul Stamets – 10 Speed Press (US) 2005 ISBN 978 1 58008 579 3 – This is more a "Why to" than a how to, but part three of the book does give details on how to grow a variety of mushrooms, covering inoculation methods, substrates, gardening with gourmet and medicinal mushrooms and nutritional properties of mushrooms. Part one talks about the mycelial mind ie lifecycle and natural habitats of mushrooms and part two is about using fungi restore damaged ecosystems using mycofiltration, mycoforestry, mycoremediation and mycopesticides. Lots of colour photos.

Mycelial Mayhem – David and Kristen Sewak – New Society Publishers (CAN) 2016 ISBN 978 0 86571 814 2 – At last! A mushroom book for us beginners! The book covers the basic mechanics of mushrooms and anatomy, lifecycle etc, how to grow easy to hard mushrooms inside or outside. Mushroom gathering form the wild is discussed, which is obviously no applicable here in Aus. There is also advice from their experience in running a mushroom business as well. Lots of B & W photos, some line drawings and a colour photo section.

The Essential Guide to Cultivating Mushrooms – Stephen Russell – Storey Publishing (US) 2014 ISBN 978 1 61212 146 8 – Lots of good stuff here. The book is broken up into 3 sections – The first is basics for beginners covering (obviously) introductory information on fungi. Types of mushrooms, basic options for growing using kits. Premade spawn, toilet rolls and plugs in logs. It also covers making a glove box and the first grow using jars. The second part covers intermediate methods including pressure cookers and flow hoods, grain spawn and liquid cultures, casing, working with sawdust and fruiting chambers. The third section covers advanced methods including agar culture, and larger scale work with large scale grain spawn and bulk substrates. Lots of colour photos.

Milkwood – Kirsten Bradley & Nick Ritar – Murdoch Books (AUS) 2018 ISBN 978 1 7336 411 6 – This is not just a book about mushrooms, but a book about 'real skills for down-to-earth living' and pages 66 to 121 cover mushroom cultivation. This book is great because it is written for Aus conditions and this stuff can be a bit hard to come by. There is an introductory bit about mushrooms in general, , easiest mushrooms for the beginner to try, then information in enough detail to carry the process out about sourcing and pasteurising the substrate, inoculating the substrate, stimulating fruiting and harvesting. They also cover using plastic bags and buckets and outdoor cultivation in logs and the ground. This book was my entry point into mushroom growing. Lots of colour photos.

Organic Mushroom Farming and Myco-remediation – Tradd Cotter – Chelsea Green Publishing (US) 2014 ISBN 978 1 60358 455 5 – This one is an encyclopaedia of fungal knowledge, and difficult to summarise in one short paragraph. It is written in four parts: the first covers the fundamentals of mushroom culture in considerable detail, the second part covers innovative application and projects using fungi including urban mushrooms and off grid mushrooming, the third covers more advanced techniques including starting your own mushroom laboratory, and part four provides detailed information on twenty four mushroom genera. Some colour drawings and photos. If you are serious about mushroom cultivation, you need this book!

Teaming with Fungi – Jeff Lowenfels – Timber Press (US) 2017 ISBN 978 1 60469 729 2 – This is not so much a 'how to grow mushrooms' as a 'how mycorrhizal fungi can improve growing just about any other plant'! The book starts out with an introduction to fungi, generally then to mycorrhizal fungi in particular. The book then provides information in using mycorrhizal fungi in agriculture, horticulture, silviculture, hydroponics and then finished off with mycorrhizae for lawns and turf. Then there is a section on growing your own mycorrhizal fungi! This is followed by some thoughts about the future of mycorrhizal fungi. Some colour diagrams and colour photos.

Crops in Tight Spots – Alex Mitchell – Kyle Books (UK) 2019 ISBN 978 0 85783 529 5 – I have lots of books in my library about growing food on a small scale and in small spaces, but this is the only one that mentions mushrooms! To be fair, it is a one page project (page 30) but gives a reasonable introduction on how to grow oyster mushrooms on egg cartons or other cardboard using commercial spawn. It is a bit of fun and this is a good book generally about growing food in small spaces.