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Onions and mushrooms: Investigating the potential of edible mushrooms as a novel product of onion waste

Onion skins represent a small but potentially significant waste stream derived from the onion industry. As they cannot be consumed by humans or animals, often these are burned or sent to landfill at cost. We identified onion skins as a potential substrate for the production of edible mushrooms and have worked to demonstrate this throughout the year. We are pleased to report a summary of our results for the two objectives as follows:

1. **Assess the potential of onion waste for the production of three types of edible mushroom: *Pleurotus* spp. and *Lentinula* sp.**

We trialled onion skin waste as a sole substrate for the production of three kinds of edible mushroom including *Pleurotus* spp. (oyster mushroom) and *Lentinula* sp. (shiitake mushroom) Both mushrooms belong to the "white rot" class of fungi and are commercially grown on straw or wood-based substrates. During the first half of 2017, we developed a robust method for the preparation and inoculation of onion skin with each type of mushroom (**Figure 1.**)

All three mushroom varieties could use onion substrate as a substrate for mycelial growth. However, we were only able to produce significant quantities of the phoenix tail oyster mushroom. **Table 1** summarises the results of the growth trials we have completed.

Table 1 Substrate colonisation time, time to primordia (immature fruiting body) appearance and yield of mature mushroom for three types of edible mushroom grown on onion skin as a sole substrate.

	Mycelium colonisation time (days)	Time to primordia appearance (after cold shock) (days)	Average mature mushroom yield (wet weight) per kilogram of onion skin
***Pleurotus* sp.1 (Phoenix tail)**	28	3	260 g
***Pleurotus* sp. 2**	28	-	-
***Lentinula* sp.**	28	15	Did not mature

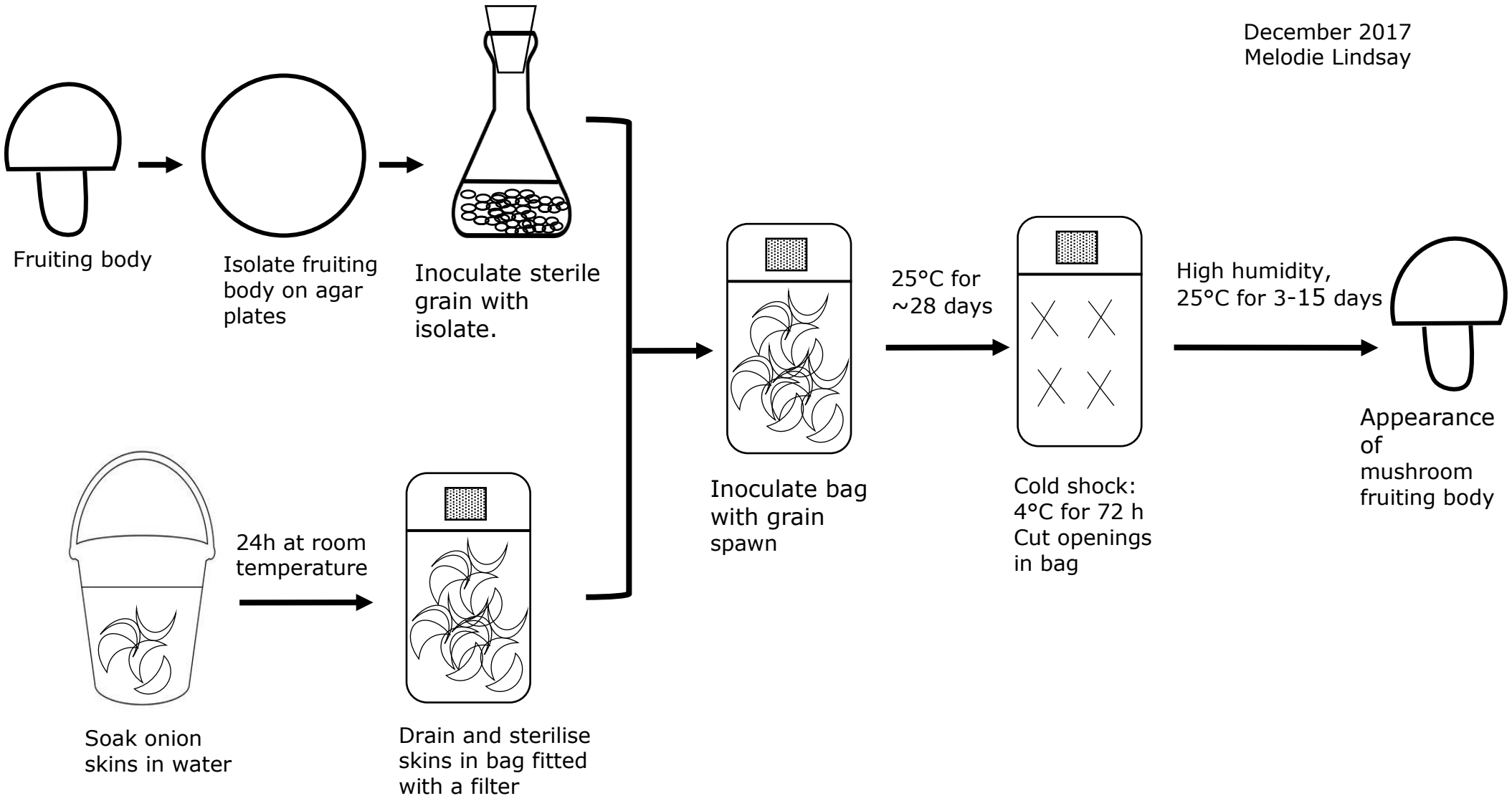

Figure 1. Overview of inoculation process and initiation of mushroom formation using onion skins as a sole substrate for the production of edible mushrooms.

Phoenix tail oyster mushroom production

We were able to produce phoenix tail oyster mushrooms in good yield. Each growth cycle takes approximately three months to complete from isolation of the fruiting body for grain spawn to the formation of mature mushrooms on the onion skin substrate. **Figure 2** shows successful growth of oyster mushrooms using onion as the sole substrate.

Figure 2 Maturing Phoenix tail oyster mushrooms growing on onion skin substrate

Figure 3 Shiitake mushroom primordia on onion skin substrate

***Lentinula* sp. mushroom production**

Shiitake mushroom production was less successful as we were unable to produce a quantity of mushroom fruiting bodies sufficient for nutritional analysis. **Figure 3** shows shiitake primordia on onion substrate. These did not mature properly using any of the growth conditions we trialled. Less than 5 g of wet weight mushroom primordia was formed which was insufficient for further compositional characterisation.

2. **Compare composition of mushrooms grown on onion waste to traditional, straw or wood grown mushrooms.**

Phoenix tail oyster mushroom was the only mushroom we could produce in large enough quantities for compositional analysis. Samples of both onion skin-grown

mushrooms and commercially grown mushrooms were dried, ground and their crude nutritional composition was compared (**Table 2**.)

Table 2 Crude nutritional composition of onion skin- and commercially grown oyster mushrooms as a percentage of dry matter (%DM).

	Commercial	Onion skin
Moisture content (%)	88	86
Crude protein (%DM)	39.8	29.7
Crude fat (%DM)	1.8	1.1
Soluble sugars (%DM)	12.8	14.0
Crude fibre (%DM)	9.5	8.9

The most significant difference was in crude protein. Oyster mushrooms grown on onion skins had approximately 25% less protein compared to commercially grown oyster mushrooms. They were also slightly lower in crude fat and crude fibre. Onion skin-derived mushrooms were marginally higher in soluble sugars compared to commercial mushrooms.

Mushrooms grown on onion skin were comparable to commercial mushrooms in both size and colour. **Figure 4** shows commercially produced oyster mushrooms compared with onion skin-grown mushrooms.

Figure 4 Mature commercially grown phoenix tail oyster mushroom (left) and mature onion skin-grown phoenix tail oyster mushroom.

Conclusions and future work

Having successfully produced phoenix tail oyster mushrooms in good yield on onion skin substrate, we plan to conduct further testing. We will do mineral testing to determine whether this differs from traditionally grown mushrooms as this may help determine if there are any potential health benefits to growing mushrooms

on onion skin despite their lower protein content. We will also test the mushrooms for heavy metals accumulation as these can be concentrated in fruiting bodies. This will help to determine whether onion skins are a valuable substrate for mushroom production suitable for human consumption.

We also are interested to see if our *Lentinula* sp. has the potential to produce mature fruiting bodies. We plan to continue to monitor the onion-skin bags as in some cases, shiitake mushrooms can take up to one year to produce fruiting bodies.

Onions New Zealand support

The ONZ scholarship has helped to support me throughout the first and second years of my PhD. Working with ONZ has given me significant insight into the horticulture industry in New Zealand. This scholarship helped to fund mushroom growing supplies as well as the nutritional testing of these mushrooms. It has been a privilege to have the support of ONZ to take this small trial to the next level and to be able to deliver some exciting results.