Mushroom Technology Literature Review

Abstract

Over 2.5 billion people do not have safe and dignified toilet. Piped water sewage systems are not viable in remote, dry, and rapidly developing areas. The waste substrate remaining after growing mushrooms can be added to dry toilets and pit latrines to control smell and treat the waste.

Background

This project builds on the masters research conducted by (Urieli, 2016) where Pleurotus fungi was used to control the smell of human faeces. Further unpublished results indicate that Pleurotus inhibit E. coli bacteria. This raises the possibility of Pleurotus being used as a novel sanitation treatment method.

The key pathogen groups in sanitation treatment are bacteria, viruses, protozoa and helminths (Strande, Ronteltap, & Brdjanovic, 2014). (Andersson et al., 2003; Šnajdr & Baldrian, 2006) show that fungi have a negative effect on bacteria populations, more specifically (Oyetayo & Ariyo, 2013) has shown that *Pluerotus ostreatus* could completely inhibit a range of bacteria. A verity of fungi decrease the viability of Helminth eggs (Blaszkowska, Wojcik, Kurnatowski, & Szwabe, 2013; Larsen, 1999), in particular *Pleurotus pulmonarius* exerts a strong immobilising effect on preinfective larvae of animal parasitic nematodes (Larsen & Nansen, 1991). Despite a lack of literature on the ability of Pleurotus spp. to control viruses and protozoa, the literature indicates Pleurotus spp. as a promising candidate for use in sanitation treatment.

With an estimated 1.5 billion people using pit latrines worldwide (WHO & UNICEF, 2014), Pleurotus could be used as a low-tech, distributed, insitu sanitation treatment. Currently pit latrines contaminate the local environment and are hazardous to empty. A Pleurotus additive for pit latrines could remove the malodour rendering the additive marketable as a “Smell Stopper”. The additive would also decrease or remove the pathogens in the waste, making the waste easier or safe to handle and dispose of in the local environment. A Pleurotus additive could be easily distributed as it is safe, extensively researched, and widely available due to its use a food source (Cohen, Persky, & Hadar, 2002).

80% of the mushroom mass produced during food production is the waste mycelium that cannot be sold as food. Spent Pleurotus substrate is a widely available waste that has already been shown to:

- Purify water by reducing phenol content and toxicity in olive mill waste (Martirani, Giardina, Marzullo, & Sannia, 1996)
- Purify soil to remove biocide pentachlorophenol (Chiu, Ching, Fong, & Moore, 1998)
- Fertilise lettuce seedlings leading to increased yields (Marques et al., 2014)
- Produce lignocellulosic enzymes for industrial applications (Phan & Sabaratnam, 2012)
- As a foodstuff for a variety of livestock (Rinker, 2002)
- A general soil supplement (Rinker, 2002)
- Combined with fresh substrate and re-inoculated (Rinker, 2002)
- Biogas production (Rinker, 2002)

Further Research

The first area of research is need to confirm that Pleurotus spp. are better at pathogen reduction than other candidates such as Stropharia used in mycofiltration (Taylor, Flatt, Wolff, Brownson, & Stamets, 2015) or Coprophilous fungi such as Coprinopsis cinerea, that grown in faeces and are known to excrete antibacterial substances (Essig et al., 2014).

The extent of the pathogen reduction is another question. Pleurotus will produce a local inhibition of bacteria (Oyetayo & Ariyo, 2013), it will need to found whether this is extends throughout the pit latrine. Not all Helminth eggs are rendered non-viable by Pleurotus (Larsen & Nansen, 1991), the degree of successful treatment will need to be accessed. Finally the effect of Pleurotus on protozoa and viruses is unknown.

Citations

Andersson, B. E., Lundstedt, S., Tornberg, K., Schnürer, Y., Öberg, L. G., & Mattiasson, B. (2003). Incomplete degradation of polycyclic aromatic hydrocarbons in soil inoculated with wood-rotting fungi and their effect on the indigenous soil bacteria. *Environmental Toxicology and Chemistry*, *22*(6), 1238–1243. http://doi.org/10.1897/1551-5028(2003)022<1238:IDOPAH>2.0.CO;2

Blaszkowska, J., Wojcik, A., Kurnatowski, P., & Szwabe, K. (2013). Biological interactions between soil saprotrophic fungi and Ascaris suum eggs. *Veterinary Parasitology*, *196*(3), 401–408. http://doi.org/10.1016/j.vetpar.2013.02.029

Chiu, S. W., Ching, M. L., Fong, K. L., & Moore, D. (1998). Spent oyster mushroom substrate performs better than many mushroom mycelia in removing the biocide pentachlorophenol. *Mycological Research*, *102*(12),

1553-1562. http://doi.org/10.1017/S0953756298007588
Cohen, R., Persky, L., & Hadar, Y. (2002). Biotechnological applications and potential of wood-degrading mushrooms of the genus Pleurotus. *Applied Microbiology and Biotechnology*, *58*(5), 582-594. http://doi.org/10.1007/s00253-002-0930-y
Curvetto, N. R., Figlas, D., Devalis, R., & Delmastro, S. (2002). Growth and productivity of different Pleurotus ostreatus strains on sunflower seed hulls supplemented with N-NH4+ and/or Mn(II). *Bioresource Technology*, *84*(2), 171-176. http://doi.org/10.1016/S0960-8524(02)00013-5
Déo, N., & Faustin, K. (2015). Effect of substrates and doses of urea on growth and yield of an oyster mushroom (Pleurotus ostreatus) in greenhouse, *3*(August), 314-322.
Essig, A., Hofmann, D., M??nch, D., Gayathri, S., K??nzler, M., Kallio, P. T., … Aebi, M. (2014). Copsin, a novel peptide-based fungal antibiotic interfering with the peptidoglycan synthesis. *Journal of Biological Chemistry*, *289*(50), 34953-34964. http://doi.org/10.1074/jbc.M114.599878
Larsen, M. (1999). Biological control of helminths. *International Journal for Parasitology*, *29*(1), 139-146. http://doi.org/10.1016/S0020-7519(98)00185-4
Larsen, M., & Nansen, P. (1991). Ability of the fungus Pleurotus pulmonarius to immobilise preparasitic nematode larvae. *Research in Veterinary Science*, *51*(3), 246-249. http://doi.org/10.1016/0034-5288(91)90071-U
Marques, E. L. S., Martos, E. T., Souza, R. J., Silva, R., Zied, D. C., & Dias, E. S. (2014). Spent mushroom compost as a substrate for the production of lettuce seedlings. *Journal of Agricultural Science*, *6*(7), p138. http://doi.org/10.5539/jas.v6n7p138
Martirani, L., Giardina, P., Marzullo, L., & Sannia, G. (1996). *Reduction of phenol content and toxicity in olive oil mill waste waters with the ligninolytic fungus Pleurotus ostreatus*. *Water Research* (Vol. 30). Pergamon.
Oyetayo, V. O., & Ariyo, O. O. (2013). Antimicrobial and Antioxidant Properties of Pleurotus ostreatus (Jacq : Fries) Cultivated on Different Tropical Woody Substrates, *1*(2), 28-32. http://doi.org/10.5147/jwcbb.2013.0121
Phan, C. W., & Sabaratnam, V. (2012). Potential uses of spent mushroom substrate and its associated lignocellulosic enzymes. *Applied Microbiology and Biotechnology*, *96*(4), 863-873. http://doi.org/10.1007/s00253-012-4446-9
Rinker, D. L. (2002). HANDLING AND USING "SPENT" MUSHROOM SUBSTRATE AROUND THE WORLD. *Mushroom Biology and Mushroom Products*, 43-60.
Šnajdr, J., & Baldrian, P. (2006). Production of lignocellulose-degrading enzymes and changes in soil bacterial communities during the growth of Pleurotus ostreatus in soil with different carbon content. *Folia Microbiologica*, *51*(6), 579-590. Journal Article, Research Support, Non-U.S. Gov't. http://doi.org/10.1007/BF02931623
Strande, L., Ronteltap, M., & Brdjanovic, D. (2014). Faecal Sludge Management, 1-427.
Taylor, A., Flatt, A., Wolff, M., Brownson, K., & Stamets, P. (2015). Removal of Escherichia coli from synthetic stormwater using mycofiltration.

Ecological Engineering, *78*, 79-86. http://doi.org/10.1016/j.ecoleng.2014.05.016
Urieli, J. (2016). *PooPac: Revolutionising container sanitation to securely transport waste at scale*. The Zurich University of Arts.
WHO, & UNICEF. (2014). *Progress on Drinking Water and Sanitation: 2014 Update*. Geneva.