

S9-1**Mushroom Diseases by Mycoviral Infections**

Hyeon-Su Ro* and Hyun-Sook Lee

*Department of Microbiology, GyeongSang National University***Mycoviruses in fungus**

Mycoviral infections in the fungi including mushrooms have been considered to cause latent infection, leading to no phenotypic effect. However recent evidences have shown that numerous cases of mushroom diseases are related to the mycoviral infections. Virulence of *Botrytis cinerea*, which infects vegetables and fruits was reportedly diminished by infection with a double-stranded RNA (dsRNA) mycovirus (Castro, 2003). Similarly, the mycoviral infections to the chestnut blight fungus, *Cryphonectria parasitica*, which essentially exterminated American chestnut tree reduced the fungal virulence (hypovirulence) (Polashock, 1994).

La France disease of white mushroom *Agaricus bisporus*

Similar to hypovirulence in pathogenic fungi, mycoviral infection affects mushroom growth and fruiting body development resulting in malformed fruiting bodies. The most known and serious virus-related disease is La France disease, which is caused by La France Isometric Virus (LIV) on *A. bisporus* (Goodin, 1992). Occasional outbreaks of the disease are considered major limiting factors in the commercial cultivation of *A. bisporus* the symptoms of this disease include degeneration of mycelium, reduced yield, malformation and premature mushroom maturation (Goodin, 1992). Due to the lack of a protection mechanism against LIV within *A. bisporus*, the disease has been controlled by removal of LIV-infected spawns before they enter cultivation facilities. Detection of LIV has been facilitated by reverse transcription-polymerase chain reaction (RT-PCR) methods.

Mycoviruses in *Pleurotus ostreatus*

Since the discovery of LIV, various types of mycoviruses have been identified in various fruiting bodies. Oyster Mushroom Spherical Virus (OMSV) was the first single-stranded RNA (ssRNA) virus discovered in *P. ostreatus* (Yu, 2003). The ssRNA genome of 5,784 bp contained 7 open reading frames, including a RNA-dependent RNA polymerase (RDRP) of 174 KDa and a coat protein (CP) of 28.5 KDa.

Recently, another *P. ostreatus*-infecting spherical dsRNA virus was discovered and named PoV1 (Lim, 2005). The genome of PoV1 consisted of two dsRNA fragments of 2.2 and 2.3 Kbp. The CP and RDRP are produced from each dsRNA fragment with protein sizes of 71.1 and 82.2 KDa, respectively. In contrast to OMSV, which is directly related to mushroom disease, infection with PoV1 did not show any distinct morphological or growth phenotypes. Moreover, a novel mycovirus was isolated from a diseased *P. ostreatus*. The virion was a 43 nm isometric virus encapsulating double-stranded RNA genome of 2.1, 2.0, 1.9, and 1.7 Kbp with a coat protein of 58 KDa. The new mycovirus was named Oyster Mushroom Isometric Virus (OMIV) (Ro, 2006)

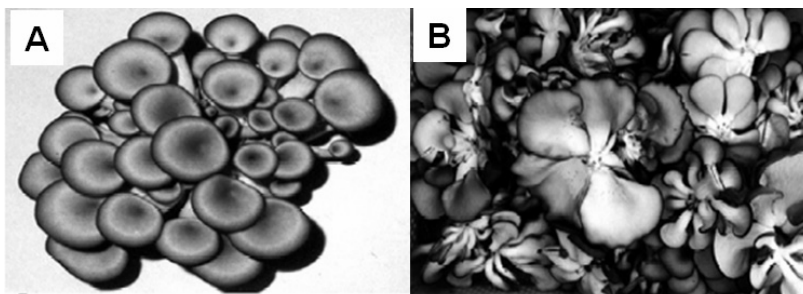


Fig. 1. Viral disease symptoms of *P. ostreatus*. A) Healthy uninfected B) Diseased

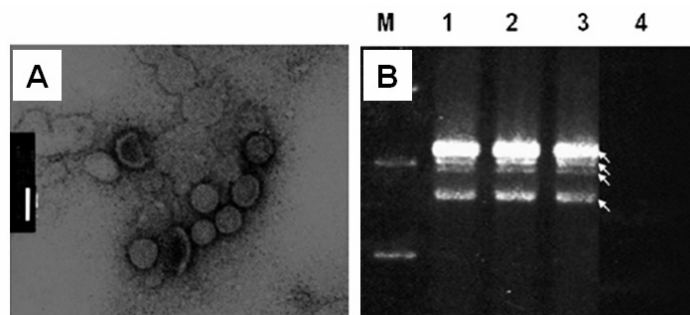


Fig. 2. OMIV from *P. ostreatus*. A) Electron micrograph B) Viral genome

Mycovirus in *Pleurotus eryngii*

P. eryngii is the most commercially successful edible mushroom in Korea since it holds more than 30% of the Korean mushroom market. However local growers sometimes suffer an unknown disease with severe epidemic symptoms. From the diseased fruiting bodies, we isolated a novel mycovirus, consisted of a single-stranded RNA (ssRNA) genome of 7.8 Kbp which was encapsulated by a coat protein of 22 KDa. named *P. eryngii* Spherical Virus (PeSV) (Ro, 2007)

Similar to LIV in *A. bisporus*, various mycoviruses infect mushrooms. We have discovered a ssRNA virus OMSV and a dsRNA virus OMIV in diseased fruiting bodies of *P. ostreatus* as well as a ssRNA virus PeSV in *P. eryngii*. Curing of the viruses essentially eliminated the symptoms, indicating that they are the causative agents of the disease. Therefore, it was conceivable that many of uncharacterized

mushroom diseases might be related to mycoviral infection.

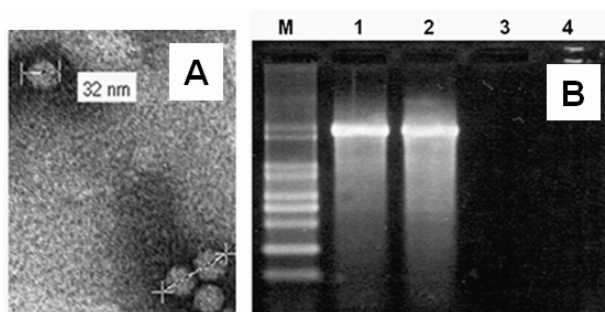


Fig. 3. PeSV from *P. eryngii*. A) Electron micrograph B) Viral genome

References

1. Castro M et al. (2003) A double-stranded RNA mycovirus confers hypovirulence- associated traits to *Botrytis cinerea*. FEMS Microbiol. Lett. 228, 87-91.
2. Goodin MM et al. (1992) Encapsidation of the La France disease-specific double-stranded RNAs in 36 nm isometric virus-like particles. Phytopathology 82, 285-290
3. Lim WS et al. (2005) Complete nucleotide sequence and genome organization of a dsRNA partitivirus infecting *Pleurotus ostreatus*. Virus Res 108, 111-119
4. Polashock JJ and Hillman BI (1994) A small mitochondrial double-stranded RNA element associated with a hypovirulent strain of the chestnut blight fungus. Proc. Natl. Acad. Sci. USA 91, 566-571.
5. Ro HS et al. (2006) Isolation of a novel mycovirus OMIV in *Pleurotus ostreatus* and its detection using a triple antibody sandwich-ELISA. J Virol Methods. 138, 24-29
6. Ro HS et al. (2007) Isolation and characterization of a novel mycovirus, PeSV, in *Pleurotus eryngii*. Biotechnol Lett. 29, 129-35
7. Yu HJ, Lim D, Lee HS (2003) Characterization of a novel single stranded RNA mycovirus in *Pleurotus ostreatus*. Virology 314, 9-15.