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Rapid risk assessment: Mushroom substrate containing horse and poultry manure

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Growing and Protecting New Zealand

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Rapid Risk Assessment: Mushroom substrate containing horse and poultry manure

Version 2.0

13 December 2016

Approved for general release

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Version information

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1.0	First peer-reviewed version	May 2016
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New Zealand is a member of the World Trade Organisation and a signatory to the Agreement on the Application of Sanitary and Phytosanitary Measures ("The Agreement"). Under the Agreement, countries must base their measures on an International Standard or an assessment of the biological risks to plant, animal or human health.

This document provides a scientific analysis of the risks associated with mushroom substrate containing horse and poultry manure. It assesses the likelihood of entry, exposure, establishment and spread of various diseases and pests in relation to imported mushroom substrate containing horse and poultry manure and assesses the potential impacts of those organisms should they enter and establish in New Zealand. The document has been internally and externally peer reviewed and is now released publically. Any significant new science information received that may alter the level of assessed risk will be included in a review, and an updated version released.

Contributors to this risk assessment

The following people provided significant input into the development of this risk analysis:

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Executive summary

MPI's Animal Imports Team has requested risk advice to enable the development of an import health standard (IHS) for mushroom growing substrate from the Netherlands.

The commodity under consideration here is derived from a combination of horse manure and poultry manure and is subject to processing twice at 80°C for 24 hours, followed by pasteurisation at 56°C for 8 hours, and finally steaming inside growing tunnels at 65°C for 10 hours.

MPI's 2008 Import Risk Analysis: Fish Food concluded that there would be no hazards in rendered poultry products. This earlier work demonstrated that heating to 80°C for 1364 minutes is equivalent to rendering. The processing conditions described for this commodity (which includes heating to 80°C for a total of 2880 minutes) are at least equivalent to rendering so no hazards would be likely to remain viable in the poultry manure incorporated in this commodity.

An assessment of the risk organisms previously identified in live horses (as described in MPI's IHS for live horses from the EU) (MPI 2015) demonstrates that several risk organisms may be found in horse manure although the heat treatment applied is sufficient to ensure none of these are likely to remain viable in the imported commodity.

No hazards have been identified in mushroom substrate containing horse and poultry manure that has been subject to the heat treatment described.

1 Introduction

MPI's Animal Imports Team has requested risk advice to enable the development of an import health standard (IHS) for mushroom substrate containing animal manure. While plant ingredient-only based mushroom substrate can be imported under the Fertilisers and Growing Media of Plant Origin Import Health Standard (MPI 2015), there is no IHS for animal manure-based substrate.

The manure will be sourced from chicken and horses in the Netherlands.

2 Commodity definition

The commodity under consideration here is composed of horse manure (90%), chicken manure and gypsum (5%), wheat straw (5%), and water, pressed in blocks (40x 60 x 20 cm) and sealed in plastic.

The substrate containing chicken and horse manure is mixed with water and processed at 80°C for 24 hours then transferred into a new mixing machine where it is also processed at 80°C for 24 hours. The substrate is then transferred to a third machine where is pasteurised at 56°C for 8 hours. Finally, the substrate is transferred into growing tunnels, which are steamed for 10 hours at 65°C (Mercer Mushrooms 2015).

3 Preliminary hazard list

MPI's Import Risk Analysis: Fish Food (MPI 2008) concluded that there would be no hazards in rendered poultry products. Appendix 3 of this earlier risk analysis showed that heating to 80°C for 1364 minutes is equivalent to rendering. Therefore, the processing conditions described for mushroom substrate as outlined in the commodity definition are at least equivalent to rendering and no hazards would be likely to remain viable in the poultry manure incorporated in this commodity.

MPI's IHS for live horses from the EU (MPI 2015), as well as the IRA: Horses and Horse Semen from the EU (MAF 2000) and Generic horse risk management recommendations from risk analysis team to the imports team (MPI 2010) lists the diseases in Table 1 as risk organisms. Table 1 presents a summary of whether these organisms would be likely to be present in horse manure and, if they are, whether they would be likely to remain viable after processing. Any organism likely to be transmitted via horse manure and remain viable following processing is identified as a hazard in the commodity and will be subject to risk assessment.

Table **1:** Likelihood of equine pathogens being transmitted via manure and their susceptibility to processing in mushroom substrate manufacture.

Disease	Aetiology	Likely to be transmitted via manure	Likely to persist after processing	Hazard?
African horse sickness	African horse sickness virus	**No**	**N/A**	**No**
African horse sickness virus is mosquito born, and disseminates in the body via the circulatory system (Thompson, Jess and Murchie 2012) (OIE 2012).				
Vesicular stomatitis	Vesicular stomatitis virus	**No**	**N/A**	**No**
Virus spreads by direct contact within a herd, present in saliva, vesicular exudates and epithelium of open vesicles (MAF 2000). Insect vectors are the primary mode of transmission (Sellon and Long 2014).				
Venezuelan equine encephalitis	Venezuelan equine encephalitis virus	**No**	**N/A**	**No**
Transmission requires insects to act as vectors (MAF 2000) (CDC 2010).				
Japanese encephalitis	Japanese encephalitis virus	**No**	**N/A**	**No**
Transmission is by mosquitoes. Horses and humans are susceptible to clinical disease in the form of encephalitis, but are dead-end hosts and are not important epidemiologically (MAF 2000).				
Eastern equine encephalitis	Eastern equine encephalitis virus	**No**	**N/A**	**No**
Eastern equine encephalitis virus (EEEV) is transmitted to humans by the bite of an infected mosquito (CDC 2010) (MAF 2000).				
Western equine encephalitis	Western equine encephalitis virus	**No**	**N/A**	**No**
Transmitted by mosquito bites to humans (MAF 2000)(Sellon and Long 2014).				

Disease	Aetiology	Likely to be transmitted via manure	Likely to persist after processing	Hazard?
Equine encephalosis	Equine encephalosis virus	**No**	**N/A**	**No**
Insect-borne orbivirus, like African horse sickness virus; transmission by mosquitoes (MAF 2000).				
Nipah	Nipah virus	**Yes**	**No**	**No**
Nipah virus is a zoonosis. Nipah is mainly a pig disease and whilst seroconversion to horses was rarely identified, horses can be exposed and develop antibodies (Sellon and Long 2014). Other studies have found that Nipah virus has an extended host range, with serological studies that imply that infection also occurred in horses and it is considered an emerging disease (Chua, et al. 2000). Henipaviruses are sensitive to temperatures higher than 22°C and pH changes from neutral (Fogarty, et al. 2008).				
Hendra	Hendra virus	**Yes**	**No**	**No**
Transmission of Hendra virus to humans can occur after exposure to body fluids and tissues or excretions of horses infected with Hendra virus (CDC 2014). Horses have been identified as the intermediate hosts, transmitting infection to humans through close contact during care or necropsy of the ill or dead horses (WHO 2015). The virus does not survive well at higher temperatures, and is inactivated in less than a day in either urine or fruit juice at 37°C (98.6°F) (Iowa State University 2009).				
Getah	Getah virus	**No**	**N/A**	**No**
Transmitted by mosquitoes (MAF 2000) or direct contact horse to horse (Sellon and Long 2014).				
Glanders	*Burkholderia mallei*	**Yes**	**No**	**No**
Transmission is by ingestion, inhalation or inoculation. Nasal discharges, pus from cutaneous lesions, urine, saliva, tears and faeces are infective. *B. mallei* is an obligate parasite, and is easily destroyed by heat, sunlight and drying (MAF 2000) (Sellon and Long 2014).				
Dourine	*Trypanosoma equiperdum*	**No**	**N/A**	**No**
Spread through sexual transmission (OIE 2013).				
Surra	***Trypanosoma evansi***	**No**	**N/A**	**No**
Transmitted through blood (Desquesnes, et al. 2013), mechanically through hematophagous biting flies (*Tabanus* spp. or *Stomoxys* spp.) or vampire bats (Sellon and Long 2014).				
Screwworm	*Cochliomyia hominivorax* and *Chrysomya Bezziana*	**No**	**N/A**	**No**
Obligate parasites and they can only exist outside mammals as pupae (OIE 2013) (Sellon and Long 2014).				
Warble fly	*Hypoderma* spp.	**No**	**N/A**	**No**
Horses are dead end hosts, accidental parasites of horses hosted near ruminants. The flies posit the eggs into the horses' hides (Sellon and Long 2014).				
Equine infectious anaemia	Equine infectious anaemia virus	**Yes**	**No**	**No**
Equine infectious anaemia (EIA) is a viraemia (OIE 2013) infecting Equidae (Sellon and Long 2014, 238). The virus is transmitted through blood but all tissues and body fluids are potentially infectious during episodes of clinical disease when viral burdens are high (The Merk Veterinary Manual 2014). EIA is a retrovirus and pasteurization of liquid plasma protein preparations at 60°C over a period of 10 hours is likely to confer safety to these products (Hilfenhaus, et al. 1985).				
Equine influenza	Influenza A viruses	**No**	**N/A**	**No**

Disease	Aetiology	Likely to be transmitted via manure	Likely to persist after processing	Hazard?
Respiratory disease, (OIE n.d.) (Sellon and Long 2014) which is transmitted via inhalation of respiratory secretions. (The Merk Veterinary Manual 2014).				
Herpesvirus	Equine herpesvirus 1	**Yes**	**No**	**No**
Infection of the respiratory tract (AAEP n.d.)(Sellon and Long 2014) Transmission occurs by direct or indirect contact with infectious nasal secretions, aborted foetuses, placentas, or placental fluids (The Merk Veterinary Manual 2014), or directly with the infectious material or through fomites. (Dunowska 2014). Heating pseudorabies virus (PRV), which is considered the model for herpes viruses and double stranded DNA viruses like EHV-1 for 30 minutes at 56°C provided fairly effective inactivation of PRV (Sofer , Lister and Boose 2003)				
Equine viral arteritis	Equine arteritis virus	**Yes**	**No**	**No**
EAV is one of the three most important equine viral respiratory pathogens. The virus is not especially resistant outside the body, and survival ≥37°C can be short-lived (Timoney, Peter J; The Merk Veterinary Manual 2013). It is transmitted through direct contact either through respiratory or venereal routes or by aerosol from urine (Sellon and Long 2014).				
Horse pox	Horsepox virus	**Yes**	**No**	**No**
The disease is transmitted by direct contact with an infected host or with contaminated grooming equipment, fomites (Sellon and Long 2014). It is likely that manure could be contaminated. A period of 15 minutes warming up to 65°C can inactivate viruses from the poxvirus family (Lelie, Reesink and Lucas 1987).				
Rabies	Rabies virus	**No**	**N/A**	**No**
Rabies is almost always attributable to a bite (any penetration of the skin by the teeth). Nonbite exposures (contamination of an open wound or a mucous membrane via scratches, licks, and inhalation of aerosol) rarely cause rabies. (Rupprecht 1996).				
Borna disease	Borna disease virus	**Yes**	**No**	**No**
Although it is suspected that BDV may be spread by bodily secretions (e.g., intranasal transmission by nasal discharge) in natural infection, there is no formal proof of this assumption. In experimental settings, BDV, in the form of concentrated virus stocks, can reach the brain by the intracranial, intranasal, peripheral (footpad), or peritoneal cavity routes (Carbone 2001). BDV experiments with rats demonstrated that the virus can be shed in urine (Sellon and Long 2014). Cell-free virion infectivity is inactivated by heating at 56°C for 0.5-3 hours (Borna Disease Virus 2015).				
Anthrax	*Bacillus anthracis*	**Yes**	**No**	**No**
Anthrax is transmitted through ingestion and spores can spread through fomites (Sellon and Long 2014). There is no evidence that anthrax is transmitted by animals before the onset of clinical and pathological signs (OIE 2010). Given the marked presentation of anthrax in horses (Sellon and Long 2014), it is highly unlikely that manure will be taken from an animal showing clinical signs so it is very unlikely that *B. anthracis* would be in the manure. Vegetative forms are killed by heating above 60°C for a few minutes (Radostits, et al. 2007). For spores, heating cow milk at 72°C requires between 204 and 1000 minutes to achieve the decimal reduction time (time to inactivate 90% of the population) (Xu, Labuza and Diez-Gonzalez 2006), which means that the processing conditions described for this commodity (which includes heating to 80°C for a total of 2880 minutes) are likely to effectively inactivate any *B. anthracis* spores present.				
Contagious equine metritis	*Taylorella equigenitalis*	**No**	**N/A**	**No**
Venereal disease (Gilbert 2015).				
Melioidosis	*Burkholderia pseudomallei*	**Yes**	**No**	**No**
Transmission of *B. pseudomallei* regularly occurs through inhalation, ingestion or direct contact with contaminated soil or water. *B. pseudomallei* is a persistent infection due its ability to survive in many harsh conditions such as, nutrient deficiency, variable pH ranges, disinfectants and antiseptic treatments, many antibiotics, and extreme temperatures. (Microbewiki 2015) The microorganism can be destroyed by heating to above 74°C for 10 minutes (Howard and Timothy 2005).				

Disease	Aetiology	Likely to be transmitted via manure	Likely to persist after processing	Hazard?
Salmonellosis	*Salmonella abortus equi*	**Yes**	**No**	**No**
Although primarily intestinal bacteria, salmonellae are widespread in the environment and commonly found in farm effluents, human sewage and in any material subject to faecal contamination (OIE 2010). Thermic processing at 80°C will assure a safe process in case the food is contaminated with the most thermally resistant serovar of Salmonella (Silva and Gibbs 2012).				
Ehrlichiosis	*Ehrlichia risticii*	**No**	**N/A**	**No**
E. risticii may be present in faeces but the biologic significance of this is unknown. *Neorickettsia* (formerly *Ehrlichia*) *risticii* is an obligate intracellular bacterium and the causative agent of Potomac horse fever (PHF). The bacterium uses a digenetic trematode vector to survive and proliferate in its natural lifecycle. It is through accidental ingestion of the metacercarial stage of the digenetic trematode within its insect host that the horse becomes infected with *N. risticii* and develops PHF (Gibson, et al. 2011).				
Ehrlichiosis	*Ehrlichia equi*	**No**	**N/A**	**No**
E. equi occurs via tick bites - *Ixodes* (The Merk Veterinary Manual 2015).				
Epizootic lymphangitis	*Histoplasma farciminosum*	**No**	**N/A**	**No**
Epizootic lymphangitis is a cutaneous, respiratory and ocular disease (Sellon and Long 2014) .*Histoplasma farciminosum* is unlikely to be present in faeces. The most common mode of infection is through direct contact with infective materials through injured skin or through cutaneous abrasions. Spread of infection can also occur indirectly through contaminated objects such as grooming tools, feeding and watering utensils, and harnesses and wound dressings and flies that fed on open wounds (Al-Ani 1999). It is unlikely that manure would be contaminated.				
Equine prioplasmosis	*Theileria equi*	**No**	**N/A**	**No**
T. equi is an obligate intracellular parasite that requires a tick host for sexual reproduction and an equine host for asexual reproduction during a haploid phase. *T. equi* can be naturally transmitted by ticks of the family *Ixodidae* and, in addition to this biological route, *T. equi* has the potential to be transmitted iatrogenically. In fact, iatrogenic transmission is thought to have been the primary mode of transmission in an outbreak in Florida, U.S., in 2008 (Hall, et al. 2013).				
Leptospirosis	*Leptospira* spp.	**Yes**	**No**	**No**
The primary source of exposure is infected urine, responsible for environmental contamination. But the organism can only survive transiently in undiluted urine. The organism is sensitive to temperatures higher than 36°C (Sellon and Long 2014).				
Endoparasites	Various	**Yes**	**No**	**No**
Complex multi-cellular organisms (acanthocephalan worms, cestodes, ectoparasites or nematodes) would be unlikely to survive the processing conditions equivalent to those described for this commodity (MPI 2008).				

4 Preliminary hazard list conclusion

As indicated above, the processing conditions described for this commodity are at least equivalent to rendering so no hazards would be likely to remain viable in the poultry manure incorporated in this commodity.

An assessment of the risk organisms previously identified in live horses (as described in MPI’s IHS for live horses from the EU) demonstrates that several risk organisms may be found in horse manure although the heat treatment applied is sufficient to ensure none of these are likely to remain viable in the imported commodity.

No hazards have been identified in mushroom substrate containing horse and poultry manure that has been subject to the heat treatment described in the commodity definition.

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