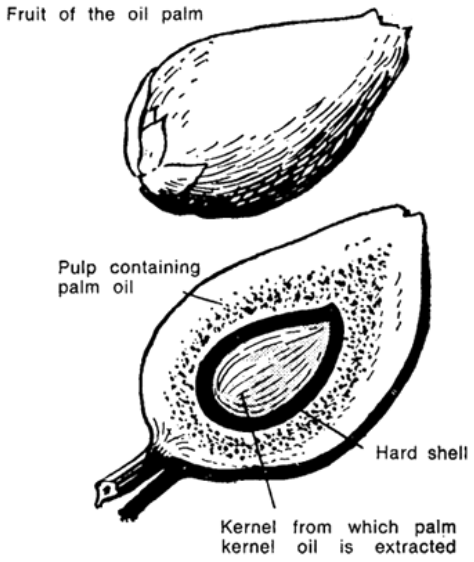
Rapid risk assessment: Foot and mouth disease virus associated with imported palm kernel extract meal



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Science and Risk Assessment
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March 2013

Approved for general release

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1. Executive summary

Palm kernel extract (PKE) meal is imported from a number of countries as supplemental feed for dairy cattle in New Zealand. Recently concerns have been raised about the risk due to contamination of imported PKE meal by livestock infected with foot and mouth disease virus (FMDV).

PKE meal is a highly processed product. There is a low risk of contamination of palm fruit bunches prior to manufacture and the processing conditions ensure any contamination on the surface of the fruit is inactivated. Subsequent separation of the nut and steam conditioning of the kernel further reduce the risk. Therefore, any contamination of unprocessed fruit prior to manufacture would be unlikely to persist during manufacture. However, if unmanaged, contamination of manufactured PKE meal prior to shipment could be a source of FMDV introduction into New Zealand.

The current import health standard for this commodity includes requirements to prevent contamination of the manufactured product during storage and transportation. Reliable certification that PKE meal has been stored and transported in a manner that avoids contact with FMDV-susceptible livestock may be sufficient to effectively manage this risk. Alternatively, manufactured PKE meal could be securely stored for a period sufficient to ensure deactivation of any contaminating FMDV prior to export (three months is suggested, reflecting the current international standard for managing the risk of FMDV associated with straw or forage from an infected country).

2. Introduction

Palm kernel extract (PKE) meal is imported from a number of countries as supplemental feed for dairy cattle in New Zealand. Recently concerns have been raised about the risk represented by contamination of imported PKE meal by livestock infected with foot and mouth disease virus (FMDV). In response to these concerns, a rapid assessment of this risk has been requested by MPI's Manager of Animal Imports and Exports.

3. Scope

This qualitative risk assessment is limited to a description of the risks due to FMDV contamination of PKE meal.

4. Commodity definition

The commodity considered in this import risk analysis is defined as PKE meal, a processed material produced under high temperatures during the extraction of palm kernel oil.

5. Risk assessment

5.1. HAZARD IDENTIFICATION

5.1.1. Aetiological agent

Family: *Picornaviridae*; Genus: *Apthovirus, foot and mouth disease virus* (FMDV). There are seven serotypes of the virus: O, A, C, SAT 1, SAT 2, SAT 3 and Asia 1 (OIE 2009).

5.1.2. OIE list

Foot and mouth disease (FMD) is listed within the category of multiple species diseases.

5.1.3. New Zealand status

FMD is an exotic notifiable disease that has never occurred in New Zealand.

5.1.4. Epidemiology

FMD is a highly contagious viral disease that causes high fever, vesicular lesions and ulcerations, and is considered to be the most economically devastating animal disease. The outbreaks of the disease in Britain in 2001 (Thompson et al 2002) and in Taiwan in 1997 (Yang et al 1999) cost those countries billions of dollars.

The disease is widespread, occurring endemically in areas of South America, Africa and Asia. Currently, there are many unresolved disease events, including outbreaks in Europe (Bulgaria), China, North and South Korea, and South Africa (WAHID 2011). The disease has been eradicated from or has not occurred in North America, Australia, and many European countries. The global distribution of FMDV is shown in Figure 1.

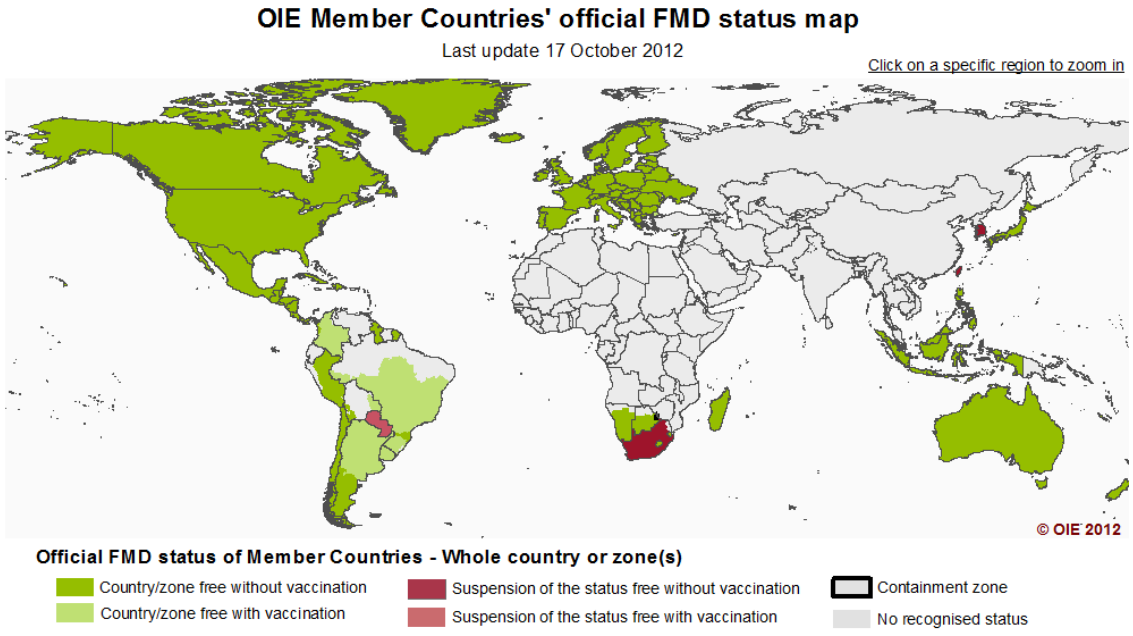

Figure 1. Global distribution of FMDV, 17 October 2012.

Host species include cattle, zebus, domestic buffaloes, yaks, sheep, goats, swine, all wild ruminants, wild *Suidae* and members of the *Camelidae* family. Although all cloven hoofed animals are susceptible, expression of disease is variable from severe clinical signs to inapparent infections (OIE 2009). Sheep may show no clinical signs whilst infectious and pigs are an important amplifying host.

The incubation period ranges from 2-14 days. However, for the purposes of the *Code* the incubation period is considered to be 14 days. Morbidity in domestic species is near 100% but is variable in wildlife. About 15-50% of cattle become carriers following infection. The virus may persist in the pharyngeal region for up to 3.5 years. The virus type influences the duration of the carrier state. However, carriers are not epidemiologically important since evidence suggests that they do not act as a source of infection (USAHA 2008). In pigs, a carrier state does not occur (Farez and Morley 1997).

The titre of virus present in animals peaks at around the time of onset of clinical signs, but significant amounts of virus may be present before this time. FMDV infected animals may excrete virus 4 days prior to clinical signs appearing (Geering et al 1995). Transmission occurs by direct contact with infected animals that excrete the virus in saliva, faeces, urine, milk, semen, and ocular and nasal discharges. Infected animal products, contaminated objects and transmission by aerosol for distances up to 60 km overland and 300 km by sea have been reported (Gloster et al 1982).

In the context of this assessment, concern has been expressed about the risk associated with post-production contamination of PKE meal following contact with infected animals. Pharo (2002) reported that saliva from FMDV-infected cattle at the peak of viraemia may contain a viral titre of up to $10^{5.25}$ to $10^{8.5}$ $TCID_{50}$/ml. Low amounts of virus are found in the faeces of infected individuals and faecal infectivity is more likely to be due to contamination by saliva or urogenital secretions. An infectious dose of 10^{6} $TCID_{50}$ is required for cattle to be infected with FMDV via the oral route (Pharo 2002).

FMDV is very sensitive to desiccation and survives poorly in aerosols when the humidity falls below 55% (Pharo 2002). Bartley et al (2002) reviewed the available literature on FMDV survival in animal excretions and on fomites, and concluded that insufficient data was available for a rigorous conclusion regarding virus persistence in a contaminated environment.

Cottral (1969) provided a summary of persistence of FMDV as a contaminant of various objects at ambient temperature. It was noted that the survival time would be shorter for free virus than for virus within cells from epithelial lesions. Also, the amount of protective colloids and tissue debris as found in mucous from the nasal and salivary discharges of infected animals would lengthen the survival time. Of relevance to this assessment, it was reported that FMDV could persist on contaminated meal for up to seven weeks (Möhlmann 1954, cited in Cottral 1969).

5.1.5. Hazard identification conclusion

FMDV is reported to have been shown to persist for up to seven weeks on contaminated meal. Therefore, FMDV is identified as a potential hazard of imported PKE meal.

5.2. RISK ASSESSMENT

5.2.1. Entry assessment

PKE meal is imported into New Zealand from several countries, with the greatest volumes coming from Indonesia and Malaysia (>95% in total). The other countries where PKE meal has been sourced from during the past five years include Papua New Guinea, Solomon Islands, Singapore, Ghana, India, and the Philippines (Olsen 2013a). FMDV is recognised to be present in Malaysia and Ghana and, although there is no official status available from the OIE, the disease is also recognised in India and the Philippines (Sumption et al 2008; WAHID 2011; Pattnaik et al 2012).

There has been a considerable increase in imported PKE meal over the last decade, from approximately 50,000 tonnes in 2004 to approximately 1.5 million tonnes in 2012. Imported volumes fluctuate, especially due to drought conditions, for example drought conditions in the Waikato in 2008 led to a significant increase in PKE meal imports that year. The following year (2009) saw a reduction in imports compared to the previous year, which is assumed to be largely due to non-drought conditions.

Most FMDV infectivity is destroyed at temperatures above 50°C (Pharo 2002) and studies have shown the *D* value (time taken for a 10-fold reduction in infectivity) for various FMDV strains to be less than six seconds above 80°C (Kamolsiripichaiporn et al 2007).

A detailed description of the manufacture of PKE meal can be found elsewhere[1], although the main steps in the process are summarised in Figure 2.

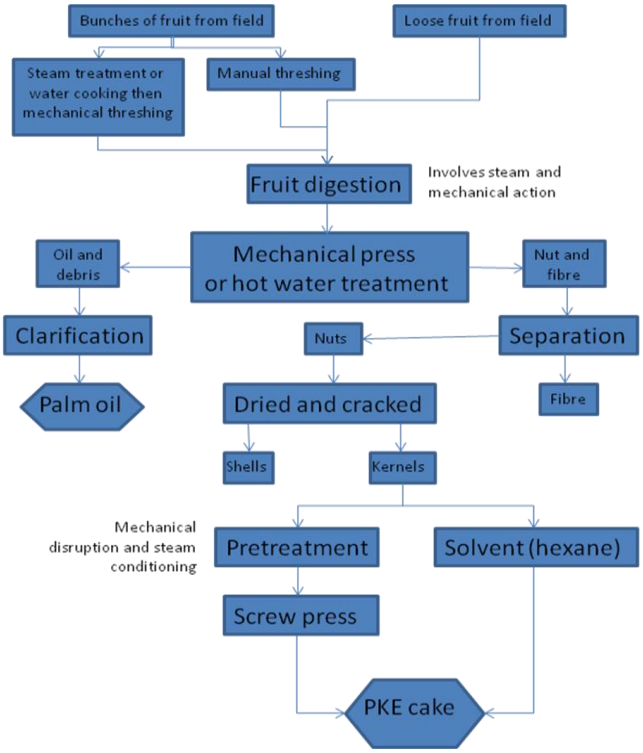

Figure 2. Main steps in the manufacture of PKE meal.

[1] http://www.fao.org/docrep/005/y4355e/y4355e06.htm, last accessed 15 March 2013

The kernel is found deep within the harvested fruit (see illustration on the cover of this assessment) so contamination of the kernel with FMDV prior to processing would be unlikely. Furthermore, PKE meal is normally cooked to a moisture content of 3 percent at 104-110°C so there is a negligible likelihood that any viral contamination of fruit would persist during this process.

This conclusion is consistent with that reached by Australia's Department of Agriculture, Fisheries and Forestry when they undertook a review of their stockfeed of plant origin policy in 2011 (Hewitt 2013):

> *There would only be a low risk of contamination of palm fruit bunches with animal faeces and other sources of animal pathogen contamination given the nature of the bunches, their collection methods and especially if collected on a commercial scale. The pressurised steam sterilisation applied to bunches, typically undertaken for large commercial processes, would ensure any animal pathogens contaminating the surface of the fruit would be inactivated. The subsequent separation of the nut and steam conditioning of the kernel would further reduce the quarantine risk.*
>
> *Palm kernel expeller (cake), produced on a large commercial scale using pressurised steam sterilisation on either the bunches or individual fruit pose a negligible animal quarantine risk provided there is no subsequent post-processing contamination of the product.*

However, contamination of manufactured meal with FMDV may occur after processing (during storage or transportation prior to export) and it has been reported that FMDV contamination of meal may persist for up to seven weeks (Möhlmann 1954, cited in Cottral 1969). No more recent publications regarding the persistence of FMDV on meal has been identified. The shipping time from Malaysia or Indonesia has been estimated to be around two to four weeks (Olsen 2013b), so, based on the available evidence, it would be reasonable to assume that any post-manufacture FMDV contamination would be present when PKE meal arrives in New Zealand.

Furthermore, studies have shown that air-dried FMDV is more resistant to thermal inactivation than FMDV suspended in milk and it is thought that high concentrations of protein will stabilise FMDV in the face of thermal inactivation (Dekker 1998).

The likelihood of entry is assessed to be non-negligible.

5.2.2. Exposure assessment

PKE meal is used for supplemental feeding of dairy cattle in New Zealand[2]. FMDV infectivity associated with post-processing contamination of PKE meal may persist during shipment and imported meal fed to recipient cattle in New Zealand.

As noted above, saliva from FMDV-infected cattle at the peak of viraemia may contain a viral titre of up to $10^{5.25}$ to $10^{8.5}$ $TCID_{50}$/ml, whereas an infectious dose of 10^{6} $TCID_{50}$ is required for cattle to be infected with FMDV via the oral route.

[2] http://www.dairynz.co.nz/file/fileid/36249, last accessed 15 March 2013

PKE meal has a dry gritty nature and is unlikely to be thoroughly mixed after manufacture. Therefore, it cannot be assumed that infectious contaminants would be diluted evenly in an imported shipment and an infectious dose of FMDV may remain localised in a contaminated shipment.

The likelihood of exposure is assessed to be non-negligible.

5.2.3. Consequence assessment

Animals that become infected could become the focal point for an outbreak of FMD. An outbreak would cause serious disruption to the livestock industries, economic losses to individual farmers, very large expenses for an eradication campaign, and significant disruption to export markets for both animals and animal products. The overall effects could be catastrophic as dramatically demonstrated by the losses that resulted from an outbreak of the disease in Britain where the costs to government were estimated at 3.1 billion pounds (Thompson et al 2002).

FMDV infection of humans is extremely rare and of no importance (Sanson 1994). Therefore, there would be negligible consequences for human health.

The virus infects cloven-hoofed animals and could infect feral pigs, goats and deer thereby establishing the disease in feral populations, which could constitute an ongoing source of infection for domestic stock.

5.2.4. Risk estimation

Since entry, exposure, and consequence assessments are non-negligible, the risk estimate is non-negligible. Accordingly, FMDV is classified as a risk in the commodity and risk management measures can be justified.

5.3. RISK MANAGEMENT

The current import health standard for processed animal feeds of plant origin[3] requires that product shipped bulk in ships' holds or in containers has:

i. been inspected after processing in accordance with appropriate official procedures, and found free from contamination by any unprocessed plant material, vermin, birds, faecal material and other animal products and visually detectable regulated pests, and

ii. been stored in substantially bird-proof buildings or bird-proof storage houses, and transported to the exit port prior to loading, in a manner to prevent contamination with any unprocessed plant material, vermin, birds, ruminant animals, faecal material and other animal products.

Alternatively, the current standard requires that product shipped in bags have been bagged in clean new bags immediately after processing and the bags stored in a manner to prevent infestation and contamination.

[3] http://www.biosecurity.govt.nz/files/ihs/bnz-pafp-imprt.pdf, last accessed 15 March 2013

As discussed above, the risk of FMDV associated with imported PKE meal is only due to contamination of the product after manufacture as the processing conditions of this commodity are such that any contamination prior to manufacture would be destroyed during processing.

Pharo (2002) summarised the available data concerning the titre of FMDV found in different tissues, secretions, and excretions of infected cattle and pigs (Table 1). FMDV contamination is most likely to occur following contact with acutely infected animals. Any measures to avoid post-manufacture contamination of PKE meal due to contact with secretions or excretions from FMDV-susceptible species (cattle, zebus, domestic buffaloes, yaks, sheep, goats, swine, all wild ruminants, wild *Suidae* and members of the *Camelidae* family) would ensure against post-manufacture contamination. For example, manufactured PKE meal could be stored in a place inaccessible to livestock, or plants manufacturing PKE meal for export could be prohibited from keeping FMD-susceptible livestock on their premises. Therefore, the current IHS measures to prevent post-manufacture contamination could be considered to effectively manage the risk.

Animal	Tissue/excretion	Stage of disease	Titre
Pig	Skin (histologically normal)	Pre-clinical (1-4 days post-exposure)	10^{9} $TCID_{50}$/g
Pig	Pharynx (soft palate, tonsil, floor of pharynx)	Pre-clinical (1-4 days post-exposure)	10^{5} – 10^{6} $TCID_{50}$/g
Cattle	Vesicular epithelium	Peak clinical signs	$10^{9.6}$ $TCID_{50}$/g
Cattle	Saliva	Several hours before clinical signs	10^{2} – $10^{3.75}$ $TCID_{50}$/ml
Cattle	Saliva	Peak clinical signs (copious production of saliva)	$10^{5.25}$ – $10^{8.5}$ $TCID_{50}$/ml
Cattle	Milk	Pre-clinical (up to 4 days before clinical signs)	$10^{6.6}$ $TCID_{50}$/g
Cattle	Semen	Peak clinical signs	$10^{6.2}$ $TCID_{50}$/ml
Cattle	Heart muscle Adrenal Retropharyngeal lymph node Blood Liver	Peak clinical signs	$10^{10.0}$ pfu/g $10^{10.6}$ pfu/g $10^{8.2}$ pfu/g $10^{5.6}$ $TCID_{50}$/g $10^{3.6}$ $TCID_{50}$/g
Cattle	Skin	Up to 5 days after cessation of viraemia	$10^{3.6}$ pfu/g

Table 1. FMDV titres in different tisues, secretions and excretions (Pharo 2002)

In addition, the OIE *Code* (Article 8.5.31) contains the following recommendation for managing the risk of FMDV associated with straw or forage from an infected country:

> Veterinary Authorities should require the presentation of an international veterinary certificate attesting that these commodities:
>
> 1. are free of grossly identifiable contamination with material of animal origin;

2. have been subjected to one of the following treatments, which, in the case of material sent in bales, has been shown to penetrate to the centre of the bale:
   a. either to the action of steam in a closed chamber such that the centre of the bales has reached a minimum temperature of 80°C for at least ten minutes,
   b. or to the action of formalin fumes (formaldehyde gas) produced by its commercial solution at 35–40 percent in a chamber kept closed for at least eight hours and at a minimum temperature of 19°C;

OR

3. have been kept in bond for at least three months (under study) before being released for export

Reflecting this recommendation, given the reported survival of FMDV on meal for seven weeks, imported PKE meal could be required to be held in secure storage free from the potential for contamination for a period of three months prior to export.

5.3.1. Options

One or a combination of the following options could be considered in order to effectively manage the risk:

Option 1

PKE meal could be imported from a country, zone, or compartment recognised to be free from FMD without additional sanitary measures.

Option 2

PKE meal could be stored and transported in a manner to avoid contamination with secretions or excretions from FMDV-susceptible species.

Option 3

PKE meal could be securely stored for a period sufficient to ensure deactivation of any contaminating FMDV prior to export (three months is suggested, reflecting the current international standard).

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