3D APPROACH
TO AFRICAN SWINE FEVER
PREPAREDNESS 2018

BANGKOK (THAILAND) • HO CHI MINH CITY (VIETNAM)
Electron micrograph of the African Swine Fever virus


Electron micrograph of the Porcine Epidemic Diarrhea virus

Source: https://wwwnc.cdc.gov/eid/article/21/3/14-1165-f1

**Lipoprotein envelope** derived from the membrane of the infected cells
Enveloped Viruses vs. Non-enveloped Viruses

1. Enveloped viruses are generally to be highly stable and survive longer due to their adaptability to different environmental conditions.

2. Enveloped viruses is sensitive to hot temperatures acidic environment, drying and formaldehyde.

3. Enveloped viruses are potent at attacking the immune system, as they can quickly adapt their 'surface protein' to mask themselves: recurrent infection is high.
African Swine Fever: Transmission

- Human to animal
- Pig to pig
- Farm-to-farm
  - Country to country
- Movement
- Feed

Same source

Air borne
Water borne
In utero

X

Human to animal
African Swine Fever: Infectivity

1. Oral-nasal route of infection

2. Shedding through excretion (feces) and secretion (urine, saliva)

3. Low infectious dose (especially for the genotype II which is highly virulent):
   a. Morbidity within 1 day of direct contact
   b. Infection within 6 days if solid partition is present
   c. 100% of animal infected within 9 days
   d. Oral route = $10^6$ TICD$_{50}$/ml

Source:
https://veterinaryrecord.bmj.com/content/178/11/262
African Swine Fever: Virus Survivability

1. The virus can be inactivated at pH < 4 and pH >11:
   a. Piglets are more susceptible because their gut is not yet fully developed
   b. The virus can survive in the gut because of the buffering effect of the feed

2. Survivability in the environment is temperature and moisture related:
   a. Infectious half-life in urine and feces is 3 – 15 days at 37°C and 4 – 8 days at
      ≤4°C (In winter, pig houses are more than 4°C)
   b. The virus can survive much longer in the feed: research has shown that the
      holding time of 78 days is recommended for amino acids, vitamin and
      mineral premixes, and 286 days for soy bean meal, from manufacturing date

3. The virus can survived for several weeks or months in uncooked as well as
   salted pork and offal. The virus is inactivated at >70°C. Typical pelleting
   temperature can inactivate the virus.

4. The virus can persist in pig carcass up to 6 months and in transboundary feed
   for more than 1 month

Sources:
1. As of 22 Oct 2018, China has reported more than 40 separate outbreaks of the ASF disease in 12 provinces and municipalities since discovering its first case in August, leading to the culling of around 200,000 animals.

2. China's three-month old outbreak of ASF has now spread for the first time to the country's south, its major pork-consuming region, signaling how deeply the deadly disease has permeated the country's pig herd, the world's largest.

3. The curb on transport of animals within China has created significant dislocations in animal and/or pork supplies. Surplus pork is weighing on markets as producers rush to market healthy stock. At the same time, prices in urban centers, along with regions in eastern and southern China, have seen as much as a 40% increase in prices.

4. China's Ministry of Agriculture and Rural Affairs declared on 25 Oct 2018 that it was banning the feeding of kitchen waste (swill) to pigs after linking the practice to the majority of the early cases of ASF.

Source:
African Swine Fever: Preparedness

1. Emergency Regional Consultative Meeting on ASF Risk Reduction and Preparedness was convened on 5-7 September 2018 in Bangkok, Thailand

2. 87 representatives attended including FAO and OIE officials, Animal Health Authorities from East Asian countries and research institutes from the European Union

3. Objectives:
   a. Assess risk to China and the rest of the East Asian region
   b. Develop an inter-governmental approach towards ASF risk reduction, preparedness and response
   c. Identify priority actions for each country

African Swine Fever: Mitigating The Risk of Transmission, Infection and Economic Loss

Trans-boundary

Herd Security
Only 10 out of 22 on-farm biosecurity measures are considered practical and effective:

1 – Active surveillance at abattoirs and rendering plants
2 – Intensive monitoring of neighboring herds
4 – Active surveillance of pigs at sentinel farms
7 – Syndromic surveillance of dead pigs
8 - Movement bans from neighboring herds
9 – Ban of swill feeding
10 – Thorough cleaning and disinfection of buildings
11 – Passive surveillance of sick pigs
12 – Farm entrance restrictions on people
13 – Containment of pigs

Source: https://veterinaryrecord.bmj.com/content/180/4/97
African Swine Fever: Mitigating The Risk of Transmission, Infection and Economic Loss

WHAT ABOUT THE PIG?

FEED (BIO)-SECURITY

IMMUNITY ENHANCEMENT
African Swine Fever: Mitigating The Risk of Transmission, Infection and Economic Loss


Source: https://www.sciencedirect.com/science/article/pii/S2405655416302402
African Swine Fever: Mitigating The Risk of Transmission, Infection and Economic Loss

WHAT ABOUT THE PIG?

FEED (BIO)-SECURITY

PATHOGEN LOAD REDUCTION

IMMUNITY ENHANCEMENT

GUT IMMUNITY PRIMING
PATHOGEN LOAD REDUCTION
Pathogen Load Reduction (PLR)

**FORMALDEHYDE-BASED BIOCIDES**
- Moderate doses in feed can inactivate enveloped viruses

**ORGANIC ACID-BASED BIOCIDES**
- More research is needed to confirm efficacy

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Electron micrograph of the African Swine Fever virus

**Formaldehyde-based Disinfectant**

<table>
<thead>
<tr>
<th>Product</th>
<th>Time</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Susceptible to ether and chloroform</td>
<td>30 minutes</td>
<td><a href="http://www.oie.int/esp/maladies/fiches/e_A120.htm">http://www.oie.int/esp/maladies/fiches/e_A120.htm</a></td>
</tr>
<tr>
<td>Inactivated by 0.8% sodium chloride</td>
<td>30 minutes</td>
<td><a href="http://www.oie.int/esp/maladies/fiches/e_A120.htm">http://www.oie.int/esp/maladies/fiches/e_A120.htm</a></td>
</tr>
<tr>
<td>Hypochlorites - 2.3% chlorine</td>
<td>30 minutes</td>
<td><a href="http://www.oie.int/esp/maladies/fiches/e_A120.htm">http://www.oie.int/esp/maladies/fiches/e_A120.htm</a></td>
</tr>
<tr>
<td>0.3% formalin</td>
<td>30 minutes</td>
<td><a href="http://www.oie.int/esp/maladies/fiches/e_A120.htm">http://www.oie.int/esp/maladies/fiches/e_A120.htm</a></td>
</tr>
<tr>
<td>3% ortho-phenylphenol</td>
<td>30 minutes</td>
<td><a href="http://www.oie.int/esp/maladies/fiches/e_A120.htm">http://www.oie.int/esp/maladies/fiches/e_A120.htm</a></td>
</tr>
<tr>
<td>Iodine compounds</td>
<td>30 minutes</td>
<td><a href="http://www.oie.int/esp/maladies/fiches/e_A120.htm">http://www.oie.int/esp/maladies/fiches/e_A120.htm</a></td>
</tr>
<tr>
<td>Slurry addition to concentration of 1% NaOH or Ca(OH)2 at 4°C</td>
<td>1 minute</td>
<td>Turner and Williams, 1999</td>
</tr>
<tr>
<td>Slurry addition to concentration of 0.5% NaOH or Ca(OH)2 at 4°C</td>
<td>30 minutes</td>
<td><a href="http://www.oie.int/esp/maladies/fiches/e_A120.htm">http://www.oie.int/esp/maladies/fiches/e_A120.htm</a></td>
</tr>
<tr>
<td>Environ (1/E) (o-phenylphenol) 1%</td>
<td>1 hour</td>
<td>Stone and Hess 1973</td>
</tr>
</tbody>
</table>

**Source:**
EFSA Journal 2010; 8(3):1556
Formaldehyde-based Biocide

Publication in BMC Veterinary Research (2014), 10:220

Conclusion of authors:

1. The study demonstrated that feed treated with a liquid formaldehyde-based product can serve as a means to reduce the risk of PEDV (an enveloped virus) infection through contaminated feed.

2. The results from the positive control group provide additional proof of concept regarding the ability of contaminated feed to serve as a risk factor for PEDV infection of naïve piglets.

Source:
Scott Dee et al. Porcine Health Management (2015) 1:9
DOI 10.1186/s40813-015-0003-0
Formaldehyde-based Biocide

Publication in Porcine Health Management, (2015), 1:9

Conclusion of authors:

1. The study demonstrated that PEDV viability in feed was influenced by the different types of feed ingredients used with extended survival in Soy Bean Meal.

2. The study further confirmed that the liquid formaldehyde-based antimicrobial rendered PEDV inactive, **independent of ingredient type used in the feed**

Source:

Scott Dee et al. BMC Veterinary Research (2016) 12:51
Pathogen Load Reduction (PLR)

Formaldehyde-based Biocide

Advanced Formulation of Sal CURB™ RM E Plus Liquid *

Highly Concentrated Source of Formaldehyde (33%)
Cost effective in inhibiting and inactivating pathogens through irreversible cross-linkages of proteins

Slow Release Formaldehyde Formulation
Effective in preventing and safeguarding feed from recontamination

Advance Surfactant Technology
Enhances the spread and penetration of the actives into feed matrix for maximum pathogen inhibition

* Recommended application rate: 2-3 kg/MT to mitigate ASF risk
GUT IMMUNITY PRIMING

3. Gut Immunity Priming
2. Pathogen Load Reduction
1. Environmental Biosecurity
Gut Immunity Priming (GIP)

Beta 1,3 Glucan: Priming Agent

Different Cytokine and Chemokines Are Used to Get the Response You Want

- IL-6
- IL-1β
- TNF-α
- IL-10
- TGF-β

Pro-Inflammatory: induce inflammation

Anti-Inflammatory: minimize inflammation

Level of Activation

- Over-activated (losing nutrients to immunity)
- “Primed”
- “Quiet”
Gut Immunity Priming (GIP)

Beta 1,3 Glucan: Priming Agent

1. Algal beta glucan taken orally

2. Macrophages + Dendritic cells ingest beta glucan

3. Beta glucan granule digested and fragments released

4. Immune System Activated

Enhanced phagocytosis of other foreign particles

Algae beta glucan + macrophage

Peyer’s Patch, Gut-associated Lymphoid tissue GALT

Kemin Internal Reference: BR-2017-00104
Gut Immunity Priming (GIP)

**Beta 1,3 Glucan: Priming Agent**

**DoE:** 80 three-week-old piglets were randomly allotted to 2 treatments with 10 pens per treatment and 4 pigs per pen, and fed experimental diets for 35 days. Three phase diets were applied according to piglets’ age. Treatments consisted of a negative control and an BG-treated group consisting of the negative control supplemented with 200 g / MT of BG. Blood was taken on day 30 to evaluate the effect of BG on the immune status, by measuring IgA and TNF-α levels.

**Kemin Internal Reference:** TL-17-00067
Beta 1,3 Glucan: Priming Agent

**DoE**: The study evaluates the impact of an experimental solubilized β-1,3-glucan (BG), on PRRSv infection and growth on porcine alveolar macrophages (PAMs) in vitro. PAMs were cultured, treated with ten-fold dilutions of BG from 10 µm/mL to 0.01 µm/mL, and infected with PRRSv. Infected PAMs were not treated with BG. Non-infected PAMs acted as negative control. Supernatants were collected at 0, 12, 24 and 36 hours. The impact of BG was measured by qRT-PCR for viral growth and by flow cytometry for viral infection. BG reduced the growth of PRRSv in a dose-dependent fashion and this effect was consistently achieved over three replicates.

Kemin Internal Reference: SD-17-00061

*In vitro* effect of solubilized algae beta-glucan on PRRSv

More than 50% reduction in viral particles with BG > 1µg/ml
Beta 1,3 Glucan: Priming Agent

**SWINE TRIAL:**
- Number of animal: 63 weaning piglets
- Start Day: Day 21 (post weaning)
- Place: 5000 pig farm size in Gyung Gi Province, South Korea
- Treatment period: 32 days (*4th Jan 2018 to 6th Feb 2018*)

<table>
<thead>
<tr>
<th>Control</th>
<th>Standard feed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment 1</td>
<td>Standard feed with essential oil @ 1,000 g/MT</td>
</tr>
<tr>
<td>Treatment 2</td>
<td>Standard feed with BG @ 200 g/MT</td>
</tr>
</tbody>
</table>

Kemin Internal Reference: SD-18-00046
# Gut Immunity Priming (GIP)

## Beta 1,3 Glucan: Priming Agent

<table>
<thead>
<tr>
<th>Parameters Measured</th>
<th>Control (C)</th>
<th>Treatment 1 (T1)</th>
<th>Treatment 2 (T2)</th>
<th>Difference (T2 - C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pigs</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>-</td>
</tr>
<tr>
<td>Total initial body wt. (kg)</td>
<td>178</td>
<td>177</td>
<td>178</td>
<td>n.d.</td>
</tr>
<tr>
<td>Total final body wt. (kg)</td>
<td>349</td>
<td>367</td>
<td>387</td>
<td>11%</td>
</tr>
<tr>
<td>Total feed intake (kg)</td>
<td>232</td>
<td>264</td>
<td>266</td>
<td>15%</td>
</tr>
<tr>
<td>Total body wt. gain (kg)</td>
<td>171</td>
<td>190</td>
<td>210</td>
<td>23%</td>
</tr>
<tr>
<td>Average daily gain (kg)</td>
<td>5.34</td>
<td>5.94</td>
<td>6.56</td>
<td>1.22</td>
</tr>
<tr>
<td>FCR</td>
<td>1.36</td>
<td>1.39</td>
<td>1.27</td>
<td>-7%</td>
</tr>
</tbody>
</table>

Kemin Internal Reference: SD-18-00046
Gut Immunity Priming (GIP)

Beta 1,3 Glucan: Priming Agent

- Gut transit
- Feces
- Urine
- Oral-nasal
- Systemic

Beta 1,3 Glucan barrier
Gut Immunity Priming (GIP)

<table>
<thead>
<tr>
<th>Different forms of beta glucan</th>
<th>Algae Beta Glucan (Aleta)</th>
<th>Yeast beta glucan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of beta glucan in raw material</td>
<td>&gt; 50%</td>
<td>5% - 15%</td>
</tr>
<tr>
<td>Form of beta glucan</td>
<td>Over 90% as linear 1,3 form</td>
<td>Less than 80% as linear 1,3, lots of 1,6 side branches</td>
</tr>
<tr>
<td>Bio-availability</td>
<td>Active in dried algae</td>
<td>Extraction required</td>
</tr>
<tr>
<td>Particle size</td>
<td>Ideal: small 1-3 micron</td>
<td>Large and variable, &gt; 10 micron</td>
</tr>
</tbody>
</table>

Journal of Hematology & Oncology 2009, 2:25
**Gut Immunity Priming (GIP)**

**Beta 1,3 Glucan: Priming Agent**

- **Algal Beta 1,3 Glucan**
  - % Cells with Particles
  - Yeast beta glucan products

- **Yeast beta glucan products**
  - Number Particles Per Cell

Kemin Internal Reference: TD-17-00307
3-D APPROACH

1. Environmental Biosecurity
2. Pathogen Load Reduction
3. Gut Immunity Priming
THANK YOU!