Half-Life Quarantine Time Calculation for Feed Ingredients

October 1, 2018

Research has demonstrated the ability for certain feed ingredients to support viral survival under laboratory conditions modeled after either trans-Atlantic or trans-Pacific shipping to U.S. ports and on to locations likely to manufacture feed for swine. This has increased interest in assuring feed ingredient safety from viruses.

The science on viral transmission through feed and feedstuffs is still relatively young, but one study has shown the theoretical ability for pathogenic swine viruses to survive transport to the United States in imported feedstuffs. More research results will come, and we'll update results accordingly.

There are two general categories of feedstuffs, those produced and handled in sealed or secure containers (examples - Vitamins, Amino Acids, etc.) and bulk feedstuffs (examples - SBM, DDGS) produced and handled in non-sealed or non-secure containers, totes, etc. Feedstuffs in either category may be produced under biosecure, non-biosecure or unknown conditions. Talk with feedstuffs suppliers about which categories and conditions apply to their offered products.

The information below is for general informational and educational purposes only and is not to be construed as recommending or advocating any specific course of action.

Current research indicates that use is safest 78 days after a 'born on' date for bagged or sealed feedstuffs and 260 days after a "born on date" for bulk feedstuffs that can't be sealed. Talk with your feed suppliers and ask for a 'born on' date for all imported feed products.

Following is more information about the research and the calculations used to identify these days.

Introduction: Research has demonstrated the ability for certain feed ingredients to support viral survival under laboratory conditions modeled after either trans-Atlantic or trans-Pacific shipping to U.S. ports and on to locations likely to manufacture feed for swine. This has increased interest in assuring feed ingredient safety from viruses. The information below is for general informational and educational purposes only and is not to be construed as recommending or advocating any specific course of action.

The science on viral transmission through feed and feedstuffs is still relatively young, but one study has shown the theoretical ability for pathogenic swine viruses to survive transport to the United States in imported feedstuffs. The feedstuffs studied that have shown the potential to support virus survival include: conventional soybean meal[1], DDGS[1], lysine hydrochloride[1], choline chloride[1], vitamin D[1], pork sausage casings1, dry and moist dog food[1], organic soybean meal[1], soy oil cake[1], moist cat food[1], and porcine-based ingredients[2]. There may be other feedstuffs that were not tested that could support survival of pathogenic viruses. Scientific study and proof-of-concept work in this area continues. To date, without an organized surveillance program, pathogenic swine viruses are not being identified in imported feedstuffs.

Imported feedstuffs are not all manufactured and handled in the same way. Consideration should be given to the conditions of manufacture and how these products are handled and transported.

1) **Ingredients in sealed or secure containers (examples - Vitamins, Amino Acids, etc.)**
    a) **Produced under biosecure conditions**
        i) Confirm with the product supplier that product safety steps and compliance are in place <u>OR</u>
        ii) FDA Foreign Supplier Verification Program and/or blockchain to confirm manufacturing conditions or handling
    b) **Produced under non-biosecure or unknown conditions**
        i) Holding the product prior to use under the appropriate time x temperature conditions to decrease risk from potential contamination
        ii) Addition of a feed-ingredient mitigant to the product preshipping may shorten, but not eliminate, the holding time <u>OR</u>
        iii) Consider not sourcing from regions/countries where FADs are present
2) **Bulk ingredients in non-sealed or non-secure containers, totes, etc. (examples - SBM, DDGS)**
    a) **Produced under biosecure conditions**
        i) Confirm with the product supplier that product safety steps and compliance are in place <u>OR</u>
        ii) FDA Foreign Supplier Verification Program and/or blockchain to confirm manufacturing conditions or handling
    b) **Produced under non-biosecure or unknown conditions**
        i) Holding the product prior to use under the appropriate time x temperature conditions to

decrease risk from potential contamination

ii) Addition of a feed-ingredient mitigant to the product preshipping may shorten, but not eliminate, the holding time OR

iii) Consider not sourcing from regions/countries where FADs are present

Seneca Valley Virus A (SVA) is in the same viral family as Foot and Mouth Disease (FMD). It was used in the experiment as a surrogate for FMD. The data suggest that the half-life time of survival ("T1/2") of SVA is longer than the T1/2 for other viruses in the experiment. Using the SVA T1/2 for calculation of holding time after manufacture and seal ("born on date") will be adequate to cover the viral degradation of other viruses.

Results of the research provide preliminary data about the T1/2 for those viruses studied under the conditions of the research. The viral T1/2 is calculated based on two data points and should be considered preliminary data. Work to strengthen the data to provide more confidence in these results is underway.

In feed ingredients of amino acids and vitamins spiked with laboratory media containing the virus, the $T^{1/2}$ of SVA is estimated to be 3 days. In soybean meal (SBM) and dried distiller grains with solubles (DDGS) spiked with laboratory media containing the virus the $T^{1/2}$ is estimated to be 10 days. Both calculations are made considering the temperature ranges of the experimental conditions, which were just less than normal room temperature.

T1/2	Remaining	
0	$1/2^0$	100%
1	$1/2^1$	50%
2	$1/2^2$	25%
...	...	...
13	$1/2^{13}$	0.01%
17	$1/2^{17}$	0.001%
13 half-lifes = 99.99% of virus inactivated 17 half-lifes = 99.999% of virus inactivated		

Applying 13 half-lives of holding time to a feed ingredient will degrade or inactivate 99.99% of a virus contaminating the feed ingredient, given certain temperature conditions. Knowing the $T^{1/2}$ of the virus, it is therefore possible to calculate the theoretical holding time after the "born on date" of the feed ingredient that would be needed to inactivate 99.99% of the viral contaminate, under those conditions.

For example,

1) $T^{1/2}$ of SVA in amino acids/vitamins = 3 days
   a) 3 days x 13 half-lives = 39 days holding time after the "born on date" to expect 99.99% inactivation

Common biosecurity practice is to calculate the time that is expected to inactivate a virus and double it, for an additional margin of safety.

   b) 39 days holding time calculated from the $T^{1/2}$, but doubled for margin of safety = 78 days total holding time after the "born on date"

The transit time to the US of the potentially contaminated feed ingredient can be applied to the total holding time after the "born on date" if the ingredient is transported in such a way that would prevent further contamination. For example:

   c) 78 days total holding time after the "born on date" – 1 day in transit = 77 days further holding time needed to meet the 78 total holding days after the "born on date"
   d) 78 days total holding time after the "born on date" – 60 days in transit = 18 days further holding time needed to meet the 78 total holding days after the "born on date"

2) $T^{1/2}$ of SVA in SBM/DDGS = 10 days
   a) 10 days x 13 half-lives = 130 days holding time after the "born on date" to expect 99.99% inactivation

Common biosecurity practice is to calculate the time that is expected to inactivate a virus and double it, for an additional margin of safety.

   b) 130 days holding time after the "born on date" calculated from the $T^{1/2}$, but doubled for margin of safety = 260 days total holding time after the "born on date"

The transit time to the US of the potentially contaminated feed ingredient can be applied to the total holding time if the ingredient is transported in such a way that would prevent further contamination. For example:

   c) 260 days total holding time after the "born on date" – 60 days in transit = 200 days further holding time needed to meet the 260 total holding days after the "born on date"

Holding time totals can be calculated according to the category of feedstuff and the "born on date".

[1] Dee., S., F. Bauermann, M. Niederwerder, A. Singrey, T. Clement, M. DeLima, C. Long, G. Patterson, M. Shehan, A. Stoian, V. Petrovan, C.K. Jones, J. De Jong, J. Ji., G Spronk, J. Hennings, J. Zimmerman, B. Rowland, E. Nelson, P. Sundberg, D. Diel, and L. Minion. 2018. Survival of viral pathogens in animal feed ingredients under transboundary shipping models. PLoS ONE. 13(3): e0194509. https://doi.org/10.1371/journal.pone.0194509

[2] Cochrane, R., S. S. Dritz, J. C. Woodworth, and C. K. Jones. 2015. Evaluating chemical mitigation of PEDv in swine feed and ingredients. J. Anim. Sci. 92(E2)090.