Holding Time Calculation for Feed Ingredients

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Summary: 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.

- Feedstuffs manufactured, sealed, handled and shipped under biosecure conditions that produces a product free of pathogens and prevents post-processing contamination are not a risk to animal health.
- Feedstuffs may become contaminated if not produced under biosecure conditions, produced under unknown conditions or not sealed to prevent post-processing contamination. The time between manufacture and use (holding time) gives an opportunity for viral contaminants to naturally degrade, so as not to be infectious.
- Current research shows a holding time of 78 days after the date of manufacture and bagging or sealing to prevent additional contamination ("born on date") for amino acids, minerals or vitamins will degrade 99.99% of viral contamination.
- Current research shows a holding time of 286 days after the "born on date" for soybean meal will degrade 99.99% of viral contamination, if shipped in a way to prevent additional contamination.
- Work to refine the holding time calculations is ongoing. Revisions and updates will be coming.

The science on viral transmission through feed and feedstuffs is still evolving, but 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. locations likely to manufacture feed for swine. This has increased interest in assuring feed ingredient safety from viruses. More research results will come, and results will be updated 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 your feedstuffs suppliers about which categories and conditions apply to their products.

For feedstuffs produced under non-biosecure or unknown conditions, current research indicates that use is safest 78 days after a 'born on' date for amino acids, minerals or vitamins bagged or sealed to prevent additional contamination and 286 days after a "born on date" for soybean meal, if shipped in a way to prevent additional contamination. Talk with your feed suppliers and ask for a 'born on' date for all imported feed products.

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 evolving, 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 casings[1], 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 OR
      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

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 OR
      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

Results of research provide preliminary data about the half-life time of survival ("$T^{1/2}$") for those viruses studied under the conditions of the experiment. The viral $T^{1/2}$ 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.

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 $T^{1/2}$ of SVA is longer than the $T^{1/2}$ for other viruses in the experiment, including African Swine Fever. Using the SVA $T^{1/2}$ for calculation of holding time after manufacture and seal ("born on date") should be adequate to cover the time needed for viral degradation of other viruses.

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 6 days. In soybean meal (SBM) spiked with laboratory media containing the virus the $T^{1/2}$ is estimated to be 22 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 = 6 days
   a) 6 days x 13 half-lives = 78 days holding time between the "born on date" and use to expect 99.99% inactivation
2) $T^{1/2}$ of SVA in SBM = 22 days
   a) 22 days x 13 half-lives = 286 days holding time between the "born on date" and use to expect 99.99% inactivation

The transit time to the US of the potentially contaminated feed ingredients will vary. If the ingredient is transported in such a way that prevents further contamination, starting the hold time at seal or bagging of feedstuffs, like amino acids or vitamins, and ending it 78 days later will account for different transit times.

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[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.