1900 Scott Ave. • Des Moines, Iowa, USA 50317 • tel: 515.559.5100 • www.kemin.com

Sal CURB® ASF Liquid Antimicrobial: Internal Research Summary

Introduction

Contaminated feed has been recognized as a source of infectious pathogens (e.g., *Salmonella spp.* in poultry and swine)[1,2,3] and poses a risk for those raising livestock and poultry to produce meat, milk and eggs. Legislation such as the Food Safety Modernization Act focuses on feed, pet food and ingredient facilities that process, pack, manufacture or hold feed to identify hazards and to have a plan to control those hazards.

To reduce the risk of microbial contamination of feed and feed ingredients, Sal CURB® ASF liquid antimicrobial (Sal CURB) should be used as part of a comprehensive pathogen control program. Sal CURB is a blend of formaldehyde and organic acids, labeled to maintain feed and feed ingredients *Salmonella*-negative for up to 21 days. Formaldehyde is a colorless, strong-smelling gas often found in aqueous solutions referred to as formalin. Formaldehyde is highly reactive, combining with amide and amino groups of proteins. This reaction is thought to give formaldehyde its antimicrobial action, cross-linking proteins in the cell envelope and elsewhere in the cell.[4]

Results Summary

The effects of Sal CURB on *Salmonella spp.* have been evaluated in a number of studies conducted by Kemin and are summarized below. The studies measured the effect of Sal CURB on *Salmonella spp.* by quantitative (e.g., cfu counts) or non-quantitative (e.g., recovery by selection method: positive vs. negative) methods. Seven studies are summarized and shown below, grouped into four categories by feed matrix and application technique (mash, pellet, post-pellet and feed ingredient).

Table 1. Effect of Sal CURB® on *Salmonella* in mash feed.

Study	Feed Type	Target (log_{10} cfu/g)	log_{10} cfu/g 0d	1d	3d	7d	14d	21d
The efficacy of Sal CURB® liquid antimicrobial against *Salmonella spp.*[5]								
Positive Control	Mash	3.7	4.2	4.0		3.7	3.1	2.9
Sal CURB (3.25 kg/t)	Mash	3.7	0.0	0.0		0.0	0.0	0.0
The efficacy of Sal CURB® ASF liquid antimicrobial against *Salmonella spp.* a dose response study[6]								
Positive Control	Mash	2.7		3.0	2.3	1.3	2.1	
Sal CURB (3.0 kg/t)	Mash	2.7		<1.0	<1.0	<1.0	<1.0	
Positive Control	Mash	3.7		4.1	3.6	2.9	1.2	
Sal CURB (3.0 kg/t)	Mash	3.7		<1.0	<1.0	<1.0	<1.0	
Positive Control	Mash	4.7		4.5	3.8	3.8	2.2	2.6
Sal CURB (3.0 kg/t)	Mash	4.7		2.7	<1.0	<1.0	<1.0	<1.0

1900 Scott Ave. • Des Moines, Iowa, USA 50317 • tel: 515.559.5100 • www.kemin.com

Table 2. Effect of Sal CURB® on *Salmonella* in pelleted feed.

Study	Feed Type	Target (log_{10} cfu/g)	% of samples positive for *Salmonella* 0d	1d	3d	8d	14d	21d
Studies to evaluate the effect of Sal CURB® on *Salmonella*, mold and pellet durability when applied to pelleted poultry feed[7]								
Positive Control	Pellet	2.7		100%		100%		
Sal CURB (3.25 kg/t)	Pellet	2.7		0%				
Positive Control	Pellet	3.7		100%		100%		
Sal CURB (3.25 kg/t)	Pellet	3.7		0%				
Positive Control	Pellet	4.0		100%		100%		
Sal CURB (3.25 kg/t)	Pellet	4.0		33%		0%		
Efficacy of Sal CURB® ASF liquid antimicrobial in expanded poultry diets[8]								
Positive Control	Mash	2.0		100%				
Sal CURB (3.25 kg/t)*	Mash	2.0		0%				
Sal CURB (3.25 kg/t)**	Mash	2.0		0%				
Positive Control	Pellet	2.0		100%				
Sal CURB (3.25 kg/t)*	Pellet	2.0		0%				
Sal CURB (3.25 kg/t)**	Pellet	2.0		0%				

*Samples treated with Sal CURB by Kemin Customer Laboratory Services.

**Sample treated with Sal CURB at customer facility

Table 3. Effect of Sal CURB® on *Salmonella* when applied post-pellet.

Study	Feed Type	Target (log_{10} cfu/g)	% of samples positive for *Salmonella* 0d	1d	8d
Studies to evaluate the effect of Sal CURB® ASF on *Salmonella*, mold and pellet durability when applied to pelleted poultry feed[7]					
Positive Control	Pellet	2.7		100%	100%
Sal CURB (3.25 kg/t)	Pellet	2.7		0%	
Positive Control	Pellet	3.7		100%	100%
Sal CURB (3.25 kg/t)	Pellet	3.7		0%	
Positive Control	Pellet	4		100%	100%
Sal CURB (3.25 kg/t)	Pellet	4		0%	0%
			0d	**1d**	**8d Re-challenge**
Efficacy of Sal CURB® ASF liquid antimicrobial applied post-pelleting against various *Salmonella* species[9]					
Positive Control	Pellet	2.7		100%	
Sal CURB (3.25 kg/t)	Pellet	2.7		0%	
Positive Control	Pellet	3.7		100%	100%
Sal CURB (3.25 kg/t)	Pellet	3.7		0%	0%

1900 Scott Ave. • Des Moines, Iowa, USA 50317 • tel: 515.559.5100 • www.kemin.com

Table 4. Effect of Sal CURB® on *Salmonella* in feed ingredients.

Study	Feed Type	Target (log_{10} cfu/g)	log_{10} cfu/g 0d	1d	3d	7d	14d	21d
Efficacy of Sal CURB® ASF liquid antimicrobial against various *Salmonella spp.* in fish meal[10]								
Positive Control	Fish Meal	4.3	4.3	4.7				0.0*
Sal CURB (3.25 kg/t)	Fish Meal	4.3	3.7	1.4				0.0*
Sal CURB (4.00 kg/t)	Fish Meal	4.3	4.2	1.0				0.0*
Sal CURB (5.00 kg/t)	Fish Meal	4.3	4.0	0.0				0.0
			% of samples positive for *Salmonella*					
			0d	7d	12d Re-challenge		17d Re-challenge	
Efficacy of Sal CURB® against *Salmonella* in a specialty ingredient matrix[11]								
Positive Control	Brewer's Yeast	2.0		100%				
Sal CURB (1.5 kg/t)	Brewer's Yeast	2.0		17%	100%			
Sal CURB (3.25 kg/t)	Brewer's Yeast	2.0		0%	0%		0%	

*Negative based on enumeration method, positive based on FDA-BAM method.

Conclusion

- Consistent response to Sal CURB across studies; decrease in *Salmonella* levels compared to control in all studies.
- Residual effect of Sal CURB provided protection when feed was re-contaminated from eight days to seventeen days.
- Sal CURB is an effective component of a comprehensive pathogen control program.

References

1. Jones F.T., Axtell R.C., Rives D.V., Sheideler S.E., Tarver F.R., Walker R.L., and Wineland M.J. (1991). A survey of Salmonella contamination in modern broiler production. *Journal of Food Protection*. 54.7: 502-507.
2. Davies R.H. and Hinton M.H. (2000). Salmonella in animal feed. In Salmonella in Domestic Animals Ed. Wray, C. and Wray, A. Oxon: CABI Publishing: 285-300.
3. Molla B., Sterman A., Mathews J. Artuso-Ponte V., Abley M., Farmer W., Rajala-Schultz P., Morrow W.M., and Gebreyes W.A. (2010). Salmonella enterica in commercial swine feed and subsequent isolation of phenotypically and genotypically related strains from fecal samples. *Applied and environmental microbiology*. 76.21: 7188-7193.
4. McDonnell G. and Russell A.D. (1999). Antiseptics and disinfectants: activity, action, and resistance. *Clinical Microbiology Reviews*. 12.1: 147-179.
5. Kemin Internal Document, 03-00797.
6. Kemin Internal Document, 03-00864.
7. Kemin Internal Document, 05-00092.
8. Kemin Internal Document, 13-00180.
9. Kemin Internal Document, 03-00090.
10. Kemin Internal Document, 04-00092.
11. Kemin Internal Document, 12-00246.