Safeguarding feed-food biosecurity

The use of organic acids for effective feed hygiene

Effective feed hygiene without formaldehyde

Good feed hygiene is about protection and prevention. It's not only imperative to animal health; it helps protect your workers, equipment, reputation, bottom line, and the entire food supply chain. Traditionally, many feed mill managers, quality managers, and nutritionists have relied on formaldehyde as a control against pathogens such as *Salmonella*, *E. coli*, and other enterobacteria. Formaldehyde, however, has been denied authorization as a feed additive in the EU. As such, the industry needs new solutions.

Organic acids are widely recognized as the best available solution for safeguarding feed-food biosecurity. They're safer for workers and, when applied to feed, can help support overall animal performance and gut health. Yet single organic acids alone are not as efficient in pathogen control as formaldehyde.

The good news is that the right combination of organic acids can be a viable alternative to formaldehyde-based solutions. Working synergistically, short- and medium-chain fatty acids, together with other bioactive ingredients, can have an acidifying effect in a broad pH range and have antimicrobial activity. When using the correct combinations of acids and bioactive compounds, there is a synergy where some components will work to increase cell permeability for other components to enter the bacterial cells and disrupt their normal function.

That's why Eastman Animal Nutrition offers the widest portfolio of organic acids available—a growing spectrum of proven solutions that ensure the safety and efficacy of your feed.

Pathogens threaten production animals

Enterobacteriaceae are a large family of bacteria—the majority regularly occurring in feeds and animals alike. They may be constituents of endogenous gut microbiota found in most animals without any indication of disease or causing any adverse effects.

But other bacteria or specific serovars of the same family, (such as *Salmonella typhimurium*, *Salmonella enteritidis*, *Escherichia coli*, *Clostridium perfringens*) are pathogenic to production animals and cause diseases that can be transferred in animal flocks and to humans.

> The overall prevalence of *Salmonella*-positive samples in animal- and vegetable-derived feed supplies in 2018 in the EU was 0.93% or 28,680 reported samples.[1]

While animals can contract *Salmonella* through their environment or even before they're born, contaminated feed remains a significant route of transmission. Safe feed is the minimum requirement to maintain animals free from *Salmonella*.

[1] *The European Union One Health 2018 Zoonoses Report, Scientific report EFSA and ECDC, 19/11/2019*

Salmonella-contaminated food is the main route for transmission of infections in humans.

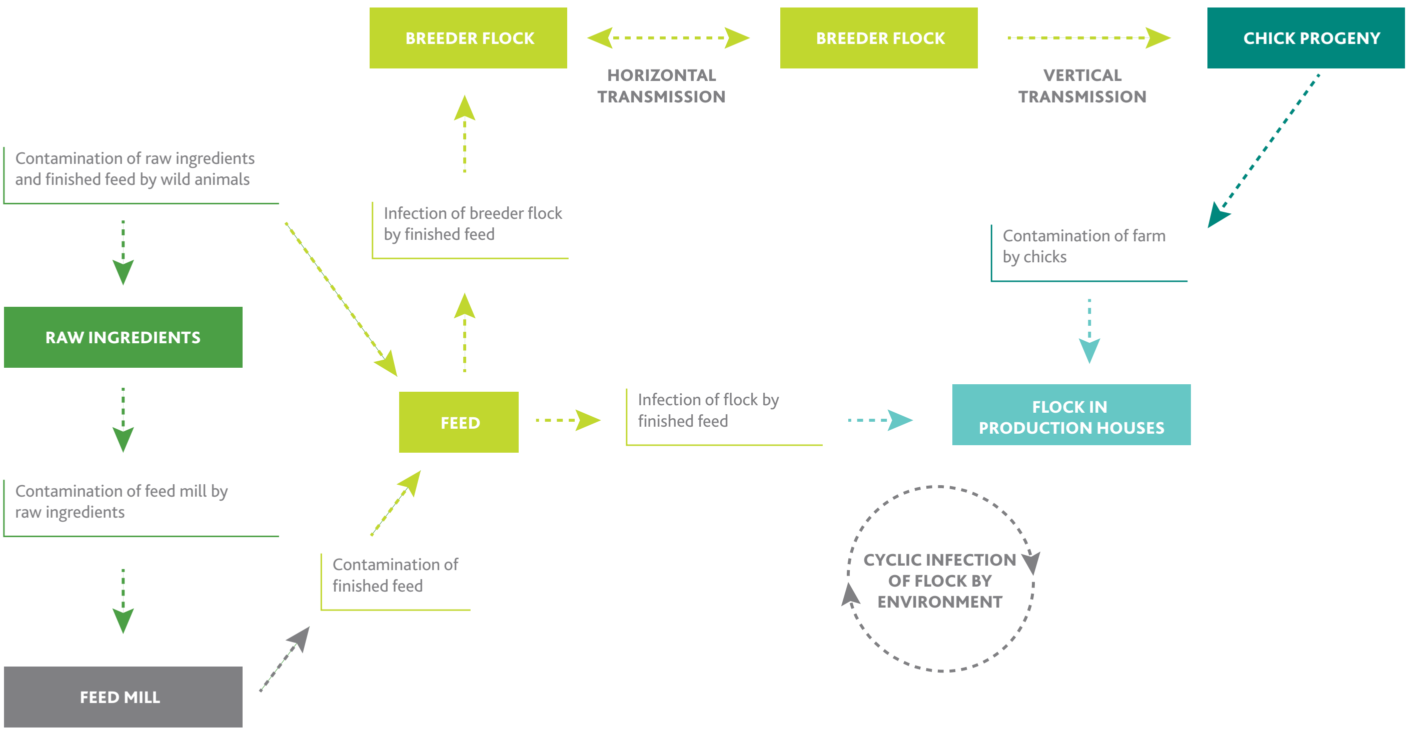
Although national control plans for *Salmonella* have been implemented in the EU for more than a decade, salmonellosis remains the second most common zoonosis in humans. In 2018, 1,580 foodborne outbreaks (FBO) were reported by 24 EU member states. Of these, *Salmonella* caused 30.7%, resulting in 11,581 human cases.[1]

Salmonella contamination routes in the farm environment

The routes of *Salmonella* contamination are complex and can come from a variety of sources such as feeds, feed ingredients, dust, water, litter, breeder chickens, and external visitors to the farm. For example, due to the absence of protective gut microflora, young chickens are more sensitive to *Salmonella* infections. In turn, the pathogen can easily transmit throughout flocks when infected young chickens are transferred from hatcheries to larger farm environments.

Additionally, due to other environmental reservoirs such as rodents and sundry birds, *Salmonella* can persist in farm environments for one year without poultry being present.

Figure 1. **Possible routes of dissemination of *Salmonella* from broiler breeder flocks to farm environments and possible routes of persistence**



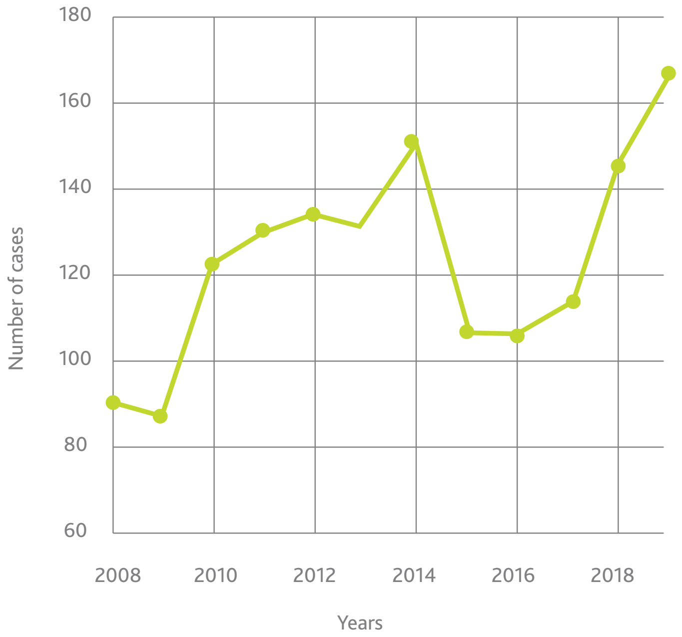
Source: Jarquin et al., *Sensors* 2009, 9, 5308-5323; doi: 10.3390/s90705308

Salmonella prevention starts at feed raw materials.

Feed raw materials such as soya, rapeseed, sunflower, and other high-protein-containing raw materials are susceptible to *Salmonella* contamination. A large proportion of *Salmonella* infections in animals originate from contaminated oil seed residue-based feed ingredients, such as soybean meal and rapeseed (canola) meal, or from recontamination after heat treatment during cooling or transport.

In the wake of the denied authorization for formaldehyde in feed uses in the EU, reported *Salmonella* cases have since increased to a new record.

Figure 2. Reported feed-based *Salmonella* cases in the EU (2008–2018)

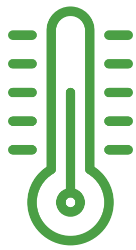


Denied authorization for formaldehyde in feed use (2018)

Source: European Commission Rapid Alert System for Food and Feed (RASFF)

Protecting feed materials from *Salmonella* contamination
Feed mill managers, quality managers, and nutritionists can take a three-pronged approach to protecting their enterprises from pathogens such as *Salmonella*:

- **Initial avoidance**
  - To avoid entry of pathogens, maintain a robust **biosecurity plan** based on Hazard Analysis and Critical Control Points (HACCP). HACCP sets control points for carriers such as pests and dust that can contribute to the distribution of harmful pathogens.
  - Monitor and improve **regular sampling and analysis** procedures for both feed and drinking water for animals.



- **Contamination control**
  - In case of contamination, control the spread by creating **adverse conditions** for bacteria growth, which is known to be influenced by pH, water activity, and temperature. This includes **acidification** of the feed material and controlling moisture content. Heat treatment can also be effective but doesn't provide prolonged protection against recontamination.

- **Recontamination avoidance**
  - Protein meal can always get recontaminated, especially in the cooling process after heat treatment and from dust in the facilities. Transportation to and handling at the feed mill are further risk points for contamination. It's important to identify and **eliminate all potential sources of contamination** and to **train personnel** involved in the manufacturing, storage, and handling chain.

Organic acids have well-recognized benefits.
Although research is ongoing to understand and document organic acids' complex and diverse functionality, their acidifying and antimicrobial properties are well recognized—in animal feeds and digestive tracts alike. Moreover, good feed acidification and bacterial control are indirectly beneficial to an animal's subsequent digestion (optimized nutritional balance). They therefore support the maintenance of an animal's good gut health and overall performance.

Organic acids are abundantly present in nature and are produced and metabolized in humans, animals, bacteria, and plants. Through their long history of use, such as preservatives for human food and animal feed, they have shown to be safe when applied at recommended quantities.

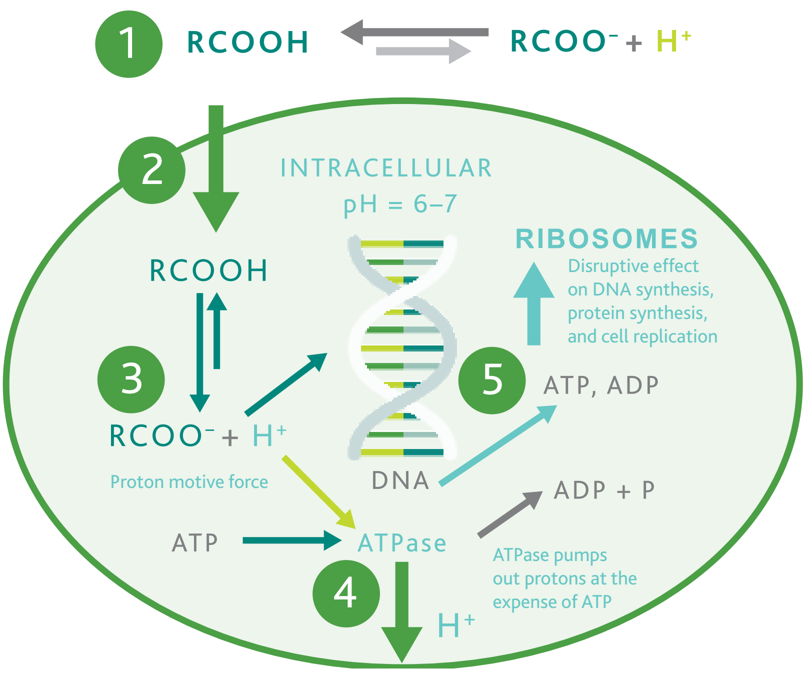
Not just any organic acid
Organic acids have different physicochemical properties that result in different functionalities in the mode of action. Depending on their chemical structures, organic acids are classified in different categories, including short-chain fatty acids (SCFA; C1-C6) and medium-chain fatty acids (MCFA; C6-C14).

Choosing the right acids—at the right proportions—to create synergistic blends is crucial to effective feed preservation and hygiene. As short-chain fatty acids, formic acid and propionic acid are key in effectively controlling bacteria and molds in feeds. By creating a blend of these acids with medium-chain fatty acids and other specific bioactive components, synergistic antimicrobial effects can be achieved.

Formic acid is an EU-authorized feed hygiene condition enhancer
Formic acid is authorized in the EU as a feed hygiene condition enhancer. Its safe use at recommended rates is particularly effective against *Salmonella* species. Formic acid, thanks to its unique physicochemical properties (being hydrophilic, having a very low pKa value, having the lowest molecular size and maximum molecules per weight unit), has the ability to easily enter and acidify the bacteria while facilitating a beneficial environment for other organic acids to contribute to the destruction of the bacteria.

As a result, formic acid presents itself as a viable alternative to formaldehyde, which—due to its carcinogenic and mutagenic properties for both animals and humans—no longer has authorization in the EU for use as a feed hygiene condition enhancer.

Figure 3. **Antimicrobial working mechanism of organic acids inside bacteria**



1. Undissociated form, H+ (proton) unreleased, lipophilic molecule
2. Diffusion; enter the bacteria cell
3. Dissociation; H+ release
4. Increased osmotic stress by H+ removal
5. Anion (RCOO-) accumulation; disruption of biomolecule synthesis and destruction of bacteria

Organic acids have selective antimicrobial action

Based on the mode of action, it's possible to target specific gram-negative and gram-positive bacteria that may be causing undesired effects in breeders and layers by applying correctly proportioned bioactive ingredients at recommended application rates. Different formulations can help target different bacteria. Organic acids can therefore function in a selective manner and allow the beneficial bacteria (like *Lactobacillus*) to remain active.

Other methods for controlling bacteria, such as heat treatment, don't allow this selectiveness. Heat destroys good bacteria along with the bad. Furthermore, ineffective heat treatment can result in health risks for the animal as well if the targeted bacteriostatic effect in the feed was not achieved.

Even after heating, recontamination can happen. Colonization of *Salmonella* in coolers is a well-recognized problem. Therefore, after heat treatment, applying organic acids is still required to prevent post-process *Salmonella* recontamination.

Figure 4. Organic acids are safe but effective hygiene condition enhancers.

What options are available?

FORMALDEHYDE

- Carcinogenic and mutagenic properties for both animals and humans
- Denied authorization for feed use by EU authorities in 2018

HEAT TREATMENT

- Nonselective approach, which can also destroy essential nutrients such as vitamins and enzymes
- No residual effect to prevent recontamination
- Costs from equipment investments, overdosing, or applying additional coating techniques

ORGANIC ACIDS

- Formic acid is an authorized feed hygiene condition enhancer in the EU, showing particular effectiveness against *Salmonella* spp.
- Well recognized for their acidification effect and antimicrobial activity in the feed, which can indirectly benefit the animals' subsequent digestion, supporting gut health and performance
- Safe for workers when handled according to recommendations

The potential of partnership

In a global market threatened by pathogens, vulnerable to climate change, challenged by market fluctuations, and regulated by evolving legislation, animal nutrition is an industry beleaguered with unknowns. It helps to partner with an industry leader.

Working in strategic partnership, feed producers can leverage Eastman's formulation expertise and decades of industry experience—steeped in scientific know-how and a collaborative approach. Eastman provides best-in-class technical expertise focused on innovation that meets customer needs; a broad and well-documented portfolio of preservation, hygiene, and gut health additives; and a shared sense of stewardship for animals and our environment.

Together, we can develop customized solutions that safeguard animal health, improve yields, and reduce costs. Our regional teams and technical experts have a deep understanding of local conditions and challenges. And, with the widest portfolio of organic acids, Eastman offers a secure supply of much-needed solutions, shared expertise throughout the value chain, and on-site support for seamless integration.

Let's talk about how **organic acids can help you achieve your feed hygiene targets**.

Contact your Eastman representative or visit **eastman.com/animalnutrition**.

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