Water Hygiene: The missing ingredient for successful ABF poultry

By T.J. Gaydos

Water quality is a frequently overlooked part of animal production and it becomes even more important when producing animals in an antibiotic-free (ABF) system. Chickens drink almost twice as much water as they consume feed, and water hygiene is often a second-level priority. Microbes present in water can be primary or secondary pathogens or non-pathogenic. Consuming impure water can add a challenge to the immune system, negatively impacting performance.

Water hygiene is essential for achieving antibiotic-free poultry production

Significant resources are spent on the correct nutrients in the diet and the correct additives for bird health. Water quality should be a priority, and a water quality monitoring program is essential for success in an ABF program. All things being equal, animals will perform better if they have access to high-quality water.

The variability of water quality in the grow-out region should determine how many water quality samples are taken. In highly variable areas, water quality should be measured at every season change on enough farms in every region to know if the solutes are changing. If the water quality is good and consistent, monitoring may be reduced significantly. Water quality should be a part of a “problem farm” work up or related to otherwise unexplained poor performance.

Water-soluble additives: Prevent biofilm

The use of water-soluble products is common in ABF production systems and their frequent use may provide a carbon source for bacteria. This, along with warm temperatures and slow water flow in enclosed water systems, makes the perfect environment for biofilm development.

It is important to frequently flush lines, give birds access to fresh water between additives, and sanitize

water lines after using a product that can provide nutrients to bacteria in the line. The biofilm is a perfect location to harbor and protect pathogens from acids and mild or under-dosed disinfectants.

Designing a water quality program

Sample collection

The first step to building a water quality program is to understand the challenge on every farm. Correct sample collection is critical to achieving good results. Take a water sample from as close to the well as possible and submit for water quality analysis: pH, hardness, and minerals. This sample should also be submitted for bacterial load: total aerobic plate count (CFU) per mL and total coliforms per mL.

Monitor bacterial load

A drip sample should be collected from the end of the line for bacterial load analysis as well. This will help determine if the bacterial challenge begins at the source or is limited to the house. Additionally, a swab from the inside of the end of the water line should be taken to determine the level of biofilm. The total bacterial count should be less than 1,000 CFU/mL without fecal coliforms in a free-flowing sample, and total bacteria should be less than 10,000 CFU/mL on a biofilm swab.

Monitor water pH

Water should have a pH between 5 and 8. Water with a pH consistently lower than 5 can be damaging to equipment, while a pH over 8 reduces the efficacy of many disinfectants and can have a bitter taste to birds. Hard water can increase scaling of lines and equipment, leading to leaking seals. Scale also provides a matrix for biofilm formation, making cleaning and disinfection more difficult.

Clean and disinfect water lines

Cleaning water lines between flocks is the minimum program for ABF production. Stabilized hydrogen peroxide products are excellent for disinfecting water lines between flocks. The levels needed for proper disinfection of lines are generally too strong for birds, and the lines must be flushed prior to bird placement.

Water lines are often only cleaned in the house; it is important to periodically clean the lines that transport water from the well or water source to the poultry house as this may be a significant reservoir for bacteria. If the well is identified as a source of contamination, it is essential to seek the help of a qualified technician before adding any sanitizing product to a wellhead.

Continuous disinfection

Ideally, water should be continuously disinfected with a product that is approved for poultry consumption. One of the best products for continuous disinfection is chlorine dioxide, which is effective at reducing bacteria and also reducing the concentrations of some mineral components. High levels of iron in the water can create a favorable environment for *E. coli* and other bacteria such as *C. perfringens*.

In addition to disinfection, chlorine dioxide is an effective treatment to reduce soluble iron levels. High sodium and chloride levels can lead to flushing and promote the growth of some bacteria. If high levels of sodium and chloride are consistent across a grow-out region, it may be possible to decrease the levels in the feed to reduce flushing. If the levels of sodium and chloride are considerably high, reverse osmosis should be considered to improve water quality.

Bottom line: invest in high-quality water

Another effective product is stabilized hydrogen peroxide at an appropriate residual level for bird consumption. There are other options for water line sanitation that can be explored on a case-by-case basis.

There are excellent online resources [link] for poultry water quality. The important message remains, in any case, that investment in high-quality water is a critical step for success in ABF poultry production.

References

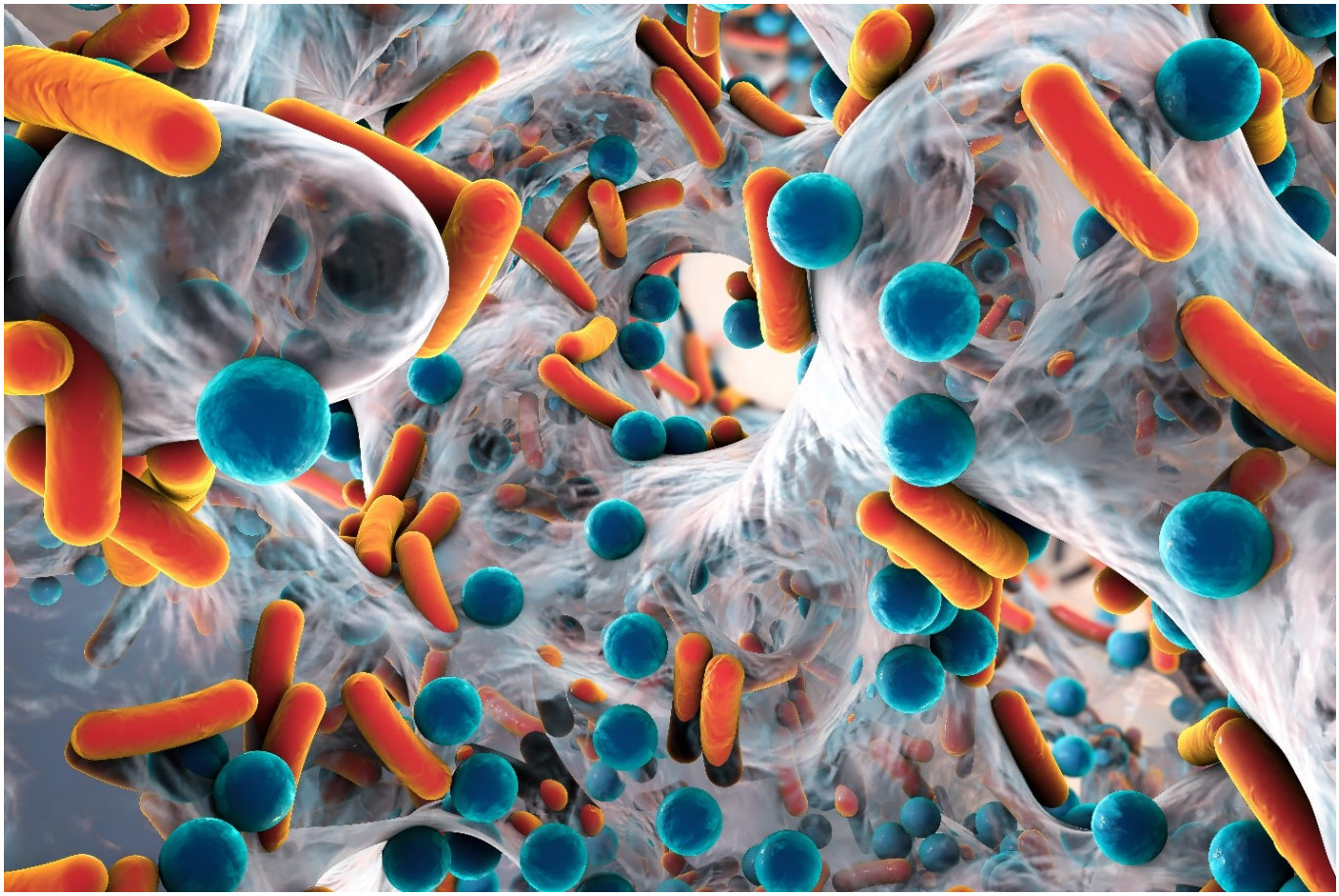
Austin, B.J., J. Payne, S.E. Watkins, M. Daniels, and B.E. Haggard. 2016. How to Collect Your Water Sample and Interpret the Results for the Poultry Analytical Package. Arkansas Water Resources Center,

Fayetteville, AR, FS-2017-01: 8 pp.

Scantling, M. and Watkins, S. 2013. Identify Poultry Water System Contamination Challenges. FSA8011. University of Arkansas Division of Agriculture Research and Extension.

Watkins, S. 2008. Water: Identifying and correcting challenges. Avian Advice 10(3):10-15. University of Arkansas Cooperative Extension Service, Fayetteville, AR

Want to reduce antibiotic use? Biosecurity and sanitation are crucial



By T.J. Gaydos

Biosecurity may not sound like an exciting topic at first, but it is a critical component of responsible poultry production. It is not enough to devise a strong biosecurity program; that program must also be followed by all people that interact within the system. It only takes one dirty boot or tire to ruin months of hard work.

Achieving good results with a flock largely depends on protecting the birds from biosecurity risks

Antibiotic reduction in poultry requires biosecurity

In a poultry operation, feed, people, and equipment constantly need to go in and out of farms and mills. Thus, no biosecurity program can be perfect. The intensity of the program needs to balance the realities of farming and the current disease pressure. The best program takes all of those into account, additionally considers local weather, availability of supplies, and company/farm staff. It is simple enough to be done even when no one is watching and should be easily scalable in case of increased disease pressure.

The rigorousness of a program must be in due proportion to the local circumstances. Having a biosecurity program that is too strict for the perceived disease pressure may result in people taking the path of least resistance. They probably will not follow instructions, especially if there is not enough monitoring and training to reinforce the value of biosecurity. On the other hand, a program with too lax guidelines will not have the desired effect.

The discrepancy between care requirements and separation

Unfortunately, the most valuable animals in an operation are often the most frequently visited by the most people. Pullets need closely monitored feedings, vaccines, and deworming. Breeders need eggs collected and shipped. Hatcheries require a labor force and maintenance. The feed mill and hatchery are central and overlapping points for all areas of the operation. The human and vehicle traffic at these locations must be closely monitored to reduce the risk of rapid disease transmission.

Feed mills are critical sites for biosecurity measures in poultry production

A physical barrier or sign indicating a biosecurity area on a farm or building entrance can help remind people of the program. Of course, these signs will not stop a disease from entering, nor a person determined to enter a site, but they will cause well-trained people to pause and reflect if they are making a sound decision.

Hygiene is a critical factor

It is well documented that hands and feet are significant transmitters of human and animal pathogens. Several studies have shown that hand washing can reduce absenteeism in school-aged children by 29-57%, thanks to a decrease in gastrointestinal diseases (Wang et al., 2017). Hand washing also reduces the incidence of respiratory illness in human populations by up to 21% (Aiello et al., 2008). *Mycoplasmas* can survive for one day in a person's nose, for up to three days in hair, and up to 3-5 days on cotton or feathers (Christensen et al., 1994). Influenza viruses endure 1-2 days on hard surfaces (Bean et al., 1982) and more than a month in pond water (Domanska-Blicharz et al., 2010).

When building a biosecurity program, it is essential to consider the relevant pathogens of concern and the practical ways to reduce their risk of transmission.

How to establish an effective biosecurity program

Generally, biosecurity comprises two important parts:

- Physical biosecurity, being the combination of all the physical barriers such as boot washes, signs, and disinfection
- Operational biosecurity, covering the processes that protect an operation. This includes downtime, visiting birds in age order, time out for birds from people visiting sick flocks, and respect for physical biosecurity measures. Operational biosecurity starts with training, not only regarding the tasks required to be secure, but also the importance of disease prevention.

Establish several zones

When designing a program, consider four zones of increasing cleanliness: off-farm, on-farm, transition zone, and the animal housing area (Figure 1). Each zone should have a control point to reduce the pathogen load coming in, with exact measures depending on current disease status and bird value. These measures include vehicle sanitation and movement restrictions, footwear cleaning and disinfection, and use of personal protective equipment (PPE).

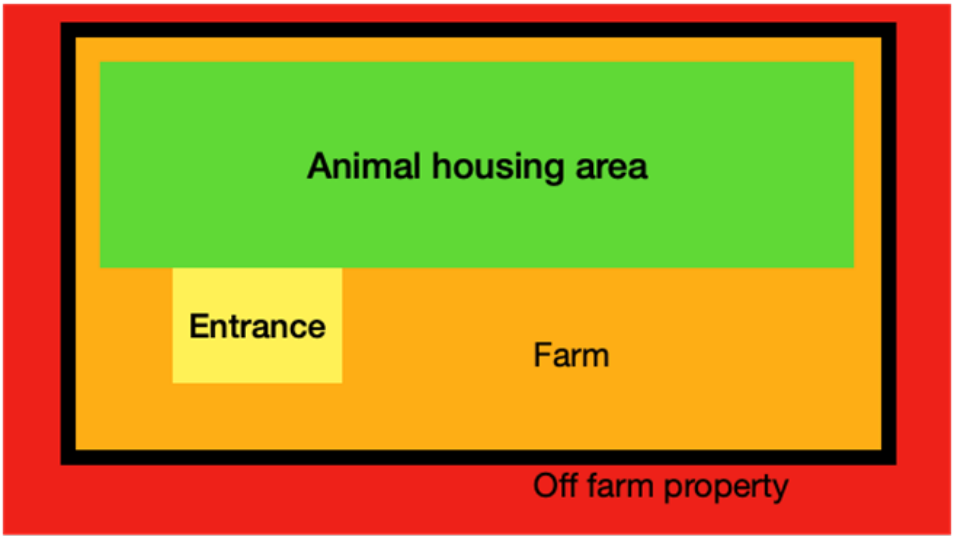


Figure 1: the four "cleanliness zones" in a farm

Increasing cleanliness from off-farm (red) to on-farm (orange) separated by a physical barrier. The entrance to the facility (transition zone; yellow) and the animal housing area (green).

Cleaning and disinfection are two of the core measures

As hands and feet are the main transmitters of pathogens, washing and sanitizing them is a priority. The outside of the house must be left outside, meaning that hands should be washed frequently and shoes sanitized between sites. Shoe covers should be put on when entering the house.

Cleanliness of the cell phone is often overlooked as a source of disease transmission (Olsen et al., 2020). It is a powerful tool: camera, notebook, light… and notoriously hard to clean. Cleaning and disinfection also apply to all shared tools and equipment that enter farms.

Prevent undesired "cohabitants"

Another critical point in biosecurity is the control of undesired pests and farm animals. Baits must be rotated, available where rodents are frequent, appropriately spaced, and secured from non-target animals. Habitats for pests need to be removed, the perimeter of the buildings must be clear of vegetation and debris, feed and grain spills picked up, and equipment stored away from the facilities. Pets and other farm animals should be kept away from the perimeter of the house and should under no circumstance be allowed to enter the facilities.

Tailored biosecurity programs keep your

flock healthy

It is impossible to design a blanket biosecurity program for every operation. Understanding microbiology and disease transmission along with the risk points in a production system will allow a comprehensive plan to be developed. It is important to consider biosecurity as an investment in health and not an optional expense. No program is perfect, but small changes can significantly reduce the risk of pathogens entering the system and leading to major economic and animal welfare issues.

References

Aiello, Allison E., Rebecca M. Coulborn, Vanessa Perez, and Elaine L. Larson. “Effect of Hand Hygiene on Infectious Disease Risk in the Community Setting: A Meta-Analysis.” *American Journal of Public Health* 98, no. 8 (2008): 1372–81. https://doi.org/10.2105/ajph.2007.124610

Bean, B., B. M. Moore, B. Sterner, L. R. Peterson, D. N. Gerding, and H. H. Balfour. “Survival of Influenza Viruses on Environmental Surfaces.” *Journal of Infectious Diseases* 146, no. 1 (1982): 47–51. https://doi.org/10.1093/infdis/146.1.47.

Christensen, N. H., Christine A. Yavari, A. J. McBain, and Janet M. Bradbury. “Investigations into the Survival of MYCOPLASMA GALLISEPTICUM, Mycoplasma Synoviae And Mycoplasma Iowae on Materials Found in the Poultry House Environment.” *Avian Pathology* 23, no. 1 (1994): 127–43. https://doi.org/10.1080/03079459408418980.

Domanska-Blicharz, Katarzyna, Zenon Minta, Krzysztof Smietanka, Sylvie Marché, and Thierry van den Berg. “H5n1 High Pathogenicity Avian Influenza Virus Survival in Different Types of Water.” *Avian Diseases* 54, no. s1 (2010): 734–37. https://doi.org/10.1637/8786-040109-resnote.1.

Olsen, Matthew, Mariana Campos, Anna Lohning, Peter Jones, John Legget, Alexandra Bannach-Brown, Simon McKirdy, Rashed Alghafri, and Lotti Tajouri. “Mobile Phones Represent a Pathway for Microbial Transmission: A Scoping Review.” *Travel Medicine and Infectious Disease* 35 (2020): 101704. https://doi.org/10.1016/j.tmaid.2020.101704.

Wang, Zhangqi, Maria Lapinski, Elizabeth Quilliam, Lee-Ann Jaykus, and Angela Fraser. “The Effect of Hand-Hygiene Interventions on Infectious Disease-Associated Absenteeism in Elementary Schools: A Systematic Literature Review.” *American Journal of Infection Control*, 2017. https://doi.org/10.1016/j.ajic.2017.01.018.

Stop feed spoilage: How organic acids can preserve feed quality

By Technical Team, EW Nutrition

Feed spoilage is a significant issue for the feed industry, leading to loss of nutrients, feed waste, and substantial economic issues for feed and animal producers worldwide (Leyva Salas et al., 2017). Fungal growth is one of the main causes of feed spoilage; it can occur at any stage of the feed production chain, including grain pre- and post-harvest processes, during feed production or storage. Organic acids and their salts are globally used in animal nutrition for microbial preservation and supporting animal health.

Organic acids help preserve animal feed and prevent spoilage through molds, yeasts, and mycotoxins

The threat of molds and yeasts in animal feed

Yeasts and molds can have both positive and negative effects on products consumed by animals and humans. On the one hand, yeasts are used to produce fermented products, such as bread, wine, and beer. On the other hand, yeasts and molds promote the spoilage of raw materials, food, and feeds (Lowes et al., 2000). Molds are among the most potent food and feed spoilers. They can be very resilient to environmental stress, which is a concern in climate change scenarios (Perrone et al., 2020) and enables them to withstand feed preservation measures (Punt et al., 2020).

Several hundred species of molds and yeasts can invade a large variety of raw materials and feeds. They show an easy adaptation to different environments; for instance, they can grow and reproduce in media with pH levels ranging from 2 to above 9 (Tournas et al., 2001). However, the majority of yeasts and molds require free oxygen to grow and thrive.

Excess moisture, high water activity, and high temperatures in feedstuffs are the main mold growth factors that concern the feed industry (Mohapatra et al., 2017). At storage, grains' moisture content should not exceed 13%, and the water activity of raw materials, feedstuffs, and finished feed should be maintained below 0.8 (Dijksterhuis et al., 2019). Controlling these points contributes to preventing the growth of most pathogens and undesirable microorganisms.

Mold growth reduces the nutritional value of feed, which affects animal health and performance

The microbiology of molds and how they affect the feed

The microbial growth dynamic of grain storage depends on several factors, including the harvest season, grain temperature and moisture content, as well as the type of facility and its environment. For instance, in some areas, grains are harvested at the beginning of the cold season and stored through the following warm season. Storage molds constitute a significant threat to the quality of these raw materials, especially during the warm months, when the stored grains may become hotter than the surrounding environment. This leads to condensation, which increases moisture and water activity. Molds easily thrive in these conditions.

Storage molds reduce the nutritional and commercial value of grains and feeds. For grains, their commercial value decreases when the appearance of kernels changes in a manner recognized by the grain industry as kernel damage. The chemical composition of feeds may deteriorate due to enzymatic actions, resulting in a loss of nutrients (energy, vitamins) and the production of free fatty acids and other unwanted by-products (Reed et al., 2007).

Extensive research has established the factors that influence mold-induced deterioration during grain storage and which management strategies are required:

- **Moisture content and water activity** (a function of the temperature, moisture content, and substrate) – Microorganisms have a limiting water activity below which they cannot grow; therefore, drying the grains below that critical level is part of an effective mold control strategy (Mannaa & Kim, 2017).
- **Temperature** – Grain-contaminating molds thrive in tropical regions, where high temperature and humidity conditions predominate. In general, molds are inactive if the grains are stored below 20 °C (Mousa et al., 2013). However, the temperature of stored grains increases as molds begin to grow in the warmer and/or wetter parts of the grain/feed mass and feed, and heat is generated due to respiration, accelerating the deterioration rate. Moreover, the presence of a temperature gradient in the feedstuffs causes air to move, accelerating the transfer of moisture to cooler grain (Mannaa & Kim, 2017).
- **Grain quality**, including previous storage conditions, insect infestation, presence of broken kernels, and impurities – When grain is too warm, the rate of insects' breeding is higher (they respond to higher temperatures), the grain contains more humidity and may carry fungal spores. Broken kernels are an easier target for mold and insect infestations than whole ones, increasing the possibility of spoilage (Marcos Valle et al., 2021).
- **Duration of storage, management, and aeration** influence the oxygen and carbon dioxide concentration in the grain mass, which plays a role in mold growth (Marcos Valle et al., 2021).

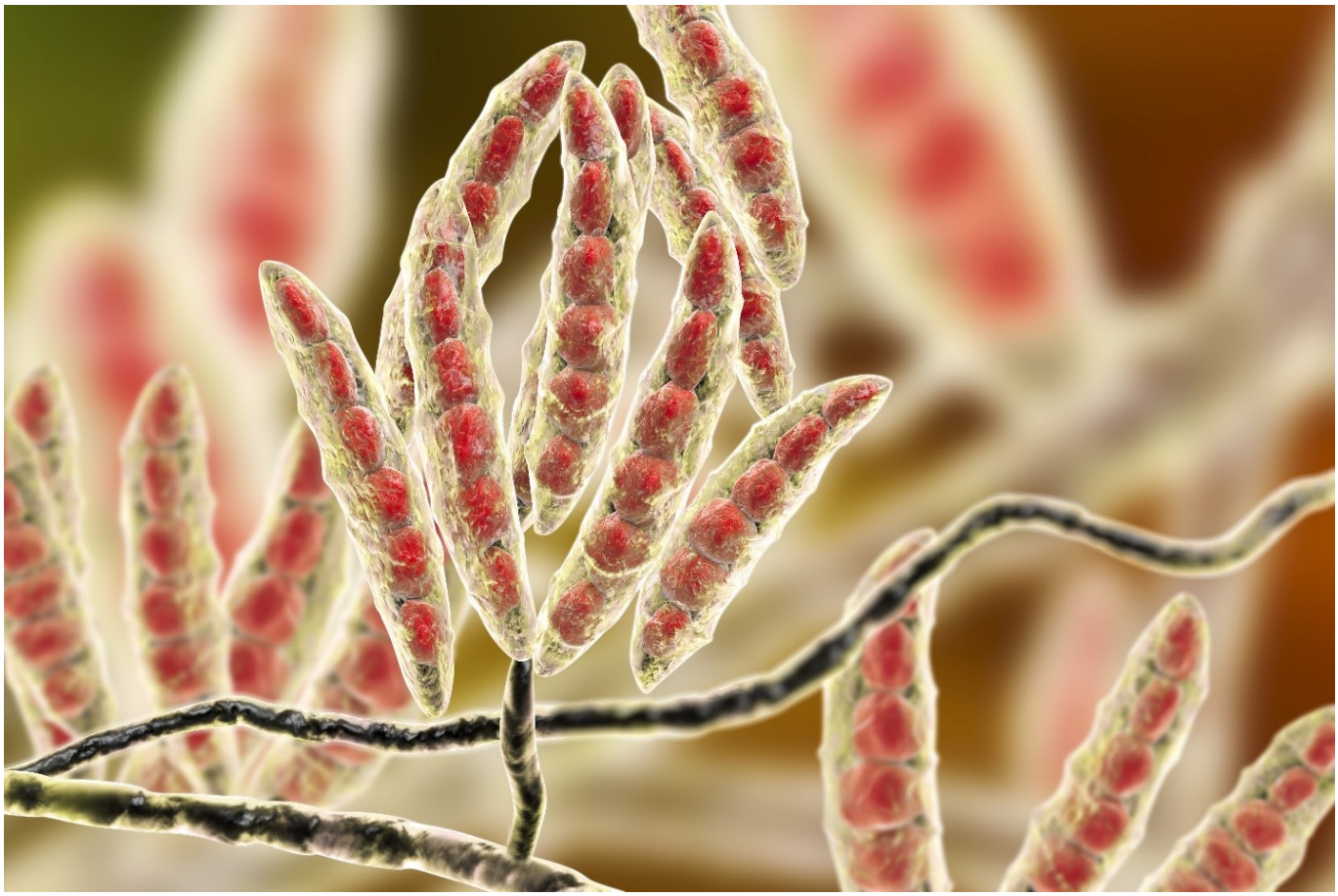
The consequences of storage deterioration include:

- worse organoleptic properties (aspect, texture, taste, and aroma) of grains and feeds
- more kernel damage,
- higher fat acidity,
- slight increase in protein content as non-protein constituents are consumed by mold respiration, causing
- lower energy value of the grain/feed (Reed et al., 2007), and
- lower content of vitamins A, B1, D3, E, and K.

Molds and mycotoxins: a toxic relationship for animal health

Beyond their negative impact on feed quality, some fungal genera such as *Aspergillus*, *Penicillium*, *Alternaria*, and *Fusarium* can produce mycotoxins, secondary metabolites that have toxic effects on humans and animals (Greco et al., 2015). Roughly 60% of raw materials produced for agriculture purposes worldwide are estimated to be contaminated by fungi and mycotoxins (Eskola et al., 2020). Mycotoxins can

induce toxic, carcinogenic, and mutagenic reactions even at low concentrations. Their presence in the final feed is a sign of alert as, usually, these metabolites are resistant to technological treatments. Thus, it is important to stop them from entering the feed production chain (Leyva Salas et al., 2017).



Feed-contaminating Fusarium species produce mycotoxins such as trichothecenes, zearalenone, and Fumonisin.

Organic acids: Unrivaled in preventing feed spoilage

It is crucial to reduce the feed losses and improve animal health by controlling fungal contamination at all stages of the feed production chain: from pre-harvest strategies on the field to post-harvest management during storage and even at feed processing. Throughout these processes, producers can apply different management practices. For instance, in field crops, fungal growth can be prevented through crop rotation and tillage; the use of fungicides is a later measure when mold presence exceeds critical levels.

Post-harvest management of grains and their by-products includes drying and storage management through moisture and temperature monitoring and aeration programs. Other spoilage-prevention measures include good hygiene practices and thermal treatments in feed production. However, feed producers and farmers face limitations in applying and linking such measures to tackle the occurrence of these undesirable pathogens (Dijksterhuis et al., 2019).

Certain organic acids, such as propionic, sorbic, benzoic, and acetic acids, have proven effective in preventing mold growth and feed spoilage. These organic acids are used globally now, not only for improving animal nutrition but also for supporting animal health (Dijksterhuis et al., 2019).

Pro-Stabil BSL is a product that harnesses the feed preservation effects of organic acids and combines them with surfactants. This means that it can offer a strong yeast and mold inhibition while maintaining the moisture in feed, thus reducing the risk of microbial challenges while prolonging the shelf life of

feedstuffs and compound feeds.

Trial results: Pro-Stabil BSL is a great tool to reduce mold growth and manage moisture

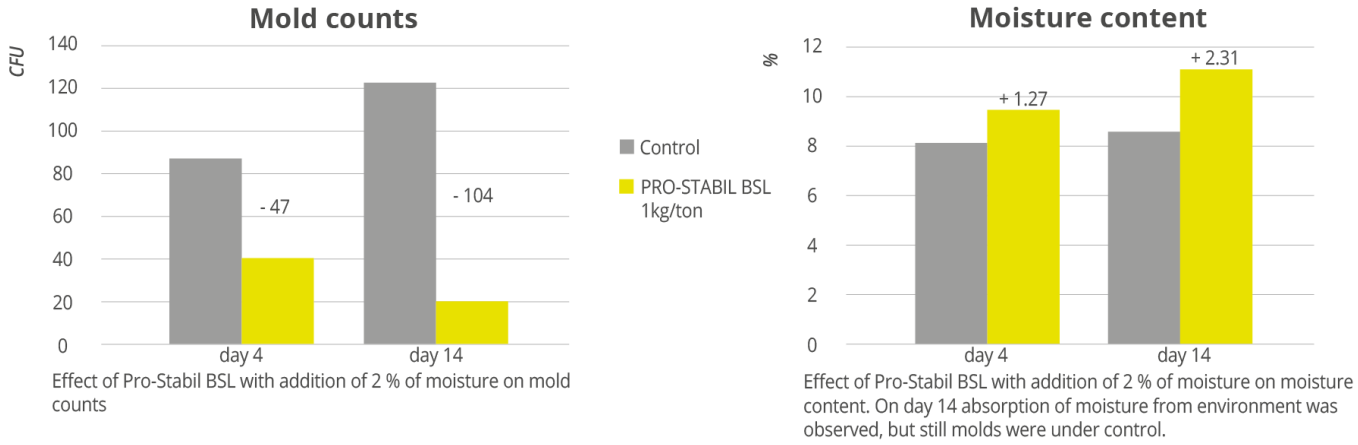
Pro-Stabil BSL contains a synergistic blend of organic acids and a surfactant that leads to

» Improved moisture dispersion in the feed

» Increased water retention (reduced water activity)

» Improved anti-mold agent dispersion in the feed and grain

Trial results show a significant decrease in mold growth when Prostabil BSL was added to compound feed. In addition, when moisture was added at 2%, moisture from the environment was also observed, but the mold counts still decreased (Figure 1).



Effect of Pro-Stabil BSL with addition of 2 % of moisture on mold counts

Effect of Pro-Stabil BSL with addition of 2 % of moisture on moisture content. On day 14 absorption of moisture from environment was observed, but still molds were under control.

Figure 1: Effects of Pro-Stabil BSL with addition of 2 % moisture on feed quality indicators

When adding Pro-Stabil BSL to animal feed, the following benefits can be expected:

- Reduction and prevention of mold growth and recontamination
- Improved moisture management
- Improved feed mill efficiency production
- Improved microbiological quality of grains and feed
- Shrinkage management by increasing moisture in feed with no risk of mold development
- Reduced water dissipation

Mold growth can lead to sensory defects in feed and reduce its nutritional value. It can also harm animals through the production of mycotoxins. Pro-Stabil BSL offers a safe solution that is also easy to handle. Using the preservative properties of organic acids, Pro-Stabil BSL helps to reduce feed spoilage and its associated effects on animal health and performance.

References

Dijksterhuis, Jan, Martin Meijer, Tineke van Doorn, Jos Houbraken, and Paul Bruinenberg. “The Preservative Propionic Acid Differentially Affects Survival of Conidia and Germ Tubes of Feed Spoilage Fungi.” *International Journal of Food Microbiology* 306 (2019): 108258. https://doi.org/10.1016/j.ijfoodmicro.2019.108258.

Eskola, Mari, Gregor Kos, Christopher T. Elliott, Jana Hajšlová, Sultan Mayar, and Rudolf Krska. “Worldwide

contamination of food-crops with mycotoxins: Validity of the widely cited 'FAO estimate' of 25%." *Critical Reviews in Food Science and Nutrition* 60, no. 16 (2020): 2773-2789. https://doi.org/10.1080/10408398.2019.1658570

Greco, Mariana, Minna Kemppainen, Graciela Pose, and Alejandro Pardo. "Taxonomic Characterization and Secondary Metabolite Profiling Of Aspergillus Section Aspergillus Contaminating Feeds And Feedstauffs." *Toxins* 7, no. 9 (2015): 3512–37. https://doi.org/10.3390/toxins7093512.

Harein, P., & Meronuck, R. (1995). Stored grain losses due to insects and molds and the importance of proper grain management. In V. Krischik, G. W. Cuperus, & D. Galliart (Eds.), Stored product management (pp. 29e31). Oklahoma Cooperative Extension Service Publication. E-912.

Leyva Salas, Marcia, Jérôme Mounier, Florence Valence, Monika Coton, Anne Thierry, and Emmanuel Coton. "Antifungal Microbial Agents for Food Biopreservation—a Review." *Microorganisms* 5, no. 3 (2017): 37. https://doi.org/10.3390/microorganisms5030037.

Lowes, K. F., C. A. Shearman, J. Payne, D. MacKenzie, D. B. Archer, R. J. Merry, and M. J. Gasson. "Prevention of Yeast Spoilage in Feed and Food by the Yeast Mycocin Hmk." *Applied and Environmental Microbiology* 66, no. 3 (2000): 1066–76. https://doi.org/10.1128/aem.66.3.1066-1076.2000.

Mannaa, Mohammed, and Ki Deok Kim. "Influence of temperature and Water activity on Deleterious fungi AND Mycotoxin production during grain storage." *Mycobiology* 45, no. 4 (2017): 240–254. https://doi.org/10.5941/myco.2017.45.4.240.

Marcos Valle, F. J., Castellari, C., Yommi, A., Pereyra, M. A., & R. Bartosik. "Evolution of grain microbiota during hermetic storage of corn (zea mays l.)." *Journal of Stored Products Research* 92 (2021): 101788. https://doi.org/10.1016/j.jspr.2021.101788.

Mohapatra, D., Kumar, S., Kotwaliwale, N., and K. K. Singh. "Critical factors responsible for fungi growth in stored food grains and non-Chemical approaches for their control." *Industrial Crops and Products* 108 (2017): 162–182. https://doi.org/10.1016/j.indcrop.2017.06.039.

Mousa, W., Ghazali, F. M., Jinap, S., Ghazali, H. M., and S. Radu. "Modeling growth rate and assessing AFLATOXINS production by Aspergillus flavusas a function of Water activity and temperature on polished and brown rice." *Journal of Food Science* 78, no. 1 (2013). https://doi.org/10.1111/j.1750-3841.2012.02986.x.

Perrone G, Ferrara M, Medina A, Pascale M, and N. Magan. "Toxigenic Fungi and Mycotoxins in a Climate Change Scenario: Ecology, Genomics, Distribution, Prediction and Prevention of the Risk." Microorganisms 8, no. 10 (2020): 1496. https://doi.org/10.3390/microorganisms8101496.

Punt, Maarten, Tom van den Brule, Wieke R. Teertstra, Jan Dijksterhuis, Heidy M.W. den Besten, Robin A. Ohm, and Han A.B. Wösten. "Impact of Maturation and Growth Temperature on Cell-size Distribution, Heat-Resistance, Compatible Solute Composition and Transcription Profiles of Penicillium Roqueforti Conidia." *Food Research International* 136 (2020): 109287. https://doi.org/10.1016/j.foodres.2020.109287.

Reed, Carl, Stella Doyungan, Brian Ioerger, and Anna Getchell. "Response of Storage Molds to Different Initial Moisture Contents of Maize (Corn) Stored AT 25°C, and Effect on Respiration Rate and Nutrient Composition." *Journal of Stored Products Research* 43, no. 4 (2007): 443–58. https://doi.org/10.1016/j.jspr.2006.12.006.

Tournas, Valerie, Michael E. Stack, Phillip B. Mislivec, Herbert A. Koch, and Ruth Bandler. "Bacteriological Analytical Manual Chapter 18: Yeasts, Molds and Mycotoxins." U.S. Food and Drug Administration. April 2001. https://www.fda.gov/food/laboratory-methods-food/bam-chapter-18-yeasts-molds-and-mycotoxins.

Feed hygiene in animal nutrition is vital – and organic acids help achieve it

by Technical Team, EW Nutrition

Feed safety is essential for animal health and performance – and food safety. Inadequate feed sanitization is still a problem across the globe. It impacts not only the feed industry and animal producers but also puts workers and consumers at risk of being exposed to harmful substances.

Developing a hygiene program for the whole feed chain needs to include proper monitoring of microbial growth, as well as feed processing methods that prevent feed contamination and enable decontamination. This article outlines the importance of feed hygiene and focuses on how organic acids help reduce contamination from “farm to fork”.

Corn is often contaminated with Aspergillus fungi that can produce poisonous mycotoxins

How to achieve feed hygiene

Feed hygiene requires the control of microorganisms throughout the feed production chain. However, producers or retailers can rarely certify or verify feedstuffs' safety due to the wide range of potential microbial contamination agents and hazards encountered in different feed environments (den Hartog, 2003). The relationship between feed and microorganisms varies, depending on the conditions: feed can transport pathogenic microorganisms and thus directly transmit disease; likewise, microorganisms can also be responsible for feed spoilage and thereby indirectly cause issues (Baer, Miller, and Dilger, 2013).

Since its foundation, the World Organization for Animal Health (OIE) has established standards, guidelines, and recommendations for toxin risk management, including for microorganisms that are transmissible via feed. Recurring outbreaks of *Salmonella*, *Escherichia coli,* and other familiar *Enterobacteriaceae* are a key concern for animal health professionals and the feed industry (Elsayed et al., 2021). However, as factors ranging from climate change to genetic mutations come into play, feed producers are working with moving targets; some of the most significant issues they might face tomorrow are unknown today. There are no easy solutions to these multifactorial problems – but in any case, corrective measures need to include quality control and quality assurance for assessing and managing the pathogenic and microbial risk situation.

To improve animal productivity sustainably, producers regularly experiment with modifying production techniques, innovating feed formulations, but also exploring new ingredients. The inclusion of new ingredients such as animal proteins, oils, and fermented products, among others, heightens the need for strict feed quality monitoring (Truelock et al., 2020). New ingredients come with causative agents of feedborne illnesses, some of which might be unknown (Goodarzi Boroojeni et al., 2016). Therefore, feed and animal producers need to consider how feed changes impact feed safety and include these hazards in their planning and risk assessments.

Better feed hygiene is crucial

For any animal production, feed processing constitutes the most crucial part of feed hygiene management, as it covers all treatments of the feed before ingestion. It is referred to as “hydrothermal processing” due to the use of heat that is required to kill most of the pathogens in raw materials, feedstuffs, and compound feed (Jones, 2011). However, whether or not hydrothermal processing will effectively eliminate a given pathogen depends on its heat resistance. Moreover, factors such as the type of feed components involved and water activity levels also need to be considered to reduce microbial pressure (Doyle and Mazzotta, 2000).

The new generation of feed milling equipment – besides elevating feed costs – can also improve feed quality (Truelock et al., 2020). These technologies tend to enhance feed stability and hygiene by modifying the physicochemical properties of the ingredients. This improves the absorption of nutrients, thereby enabling a higher feed intake efficiency with positive results for animal performance (Abdollahi, Svihus, and Ravindran, 2013). However, while increasing processing time at a given temperature can lead to a better decontamination process, it can also negatively affect some nutrients’ dynamics. This includes enzymes, proteins, minerals, vitamins, fiber and starch, and especially non-starch polysaccharides (Goodarzi Boroojeni et al., 2014).

Organic acids as a solution of feed hygiene risk management

Hence, while significant progress in feed science and feed production technology has already been made, researchers and the industry are still searching for alternative approaches to supporting feed hygiene (Goodarzi Boroojeni et al., 2016). Organic acids are a central research field as they offer promising antimicrobial properties. In combination with feed mill techniques, they already play an essential role in feed preservation (Brul et al., 2002). Despite their efficacy in inhibiting microbial growth, weak organic acids are safe to handle (especially when they are buffered) compared to inorganic acids.

In addition to their preservative effect in feed, it has been shown that organic acids can support gut health. They are not just antimicrobial agents but also acidifiers that display their impact in the stomachs of monogastric animals (Tugnoli et al., 2020).

A combined solution for microbial contamination challenges

To support the feed industry and animal production in light of feed safety challenges in AGP-free production, EW Nutrition focuses research efforts on maximizing the beneficial effect of organic acids. The ACIDOMIX range of products supports the stabilization of the gastrointestinal microflora, inhibiting pathogenic bacterial growth in feed and water. Acidomix is an efficient acidifier specially formulated to have strong antimicrobial effects applicable in feed hygiene programs. Various powder and liquid solutions offer a wide range of benefits:

- Strong antimicrobial effect, supporting the prevention of bacterial infections
- Reducing the incidence of dysbiosis
- Acidifying the feed and digestive tract
- Supporting the improvement of production performance
- Preventing feed re-contamination
- Flexible application

Feedstuffs and compound feed are at risk of contamination and re-contamination throughout the feed production chain: processing, transportation, delivery, storage, and on-farm. Thus, a holistic and

integrated approach that includes optimized feed mill processing and customized organic acids is required to improve the feed's hygiene status. The positive effects are clear: feed producers benefit economically, animal producers reap the effects of improved animal health and performance, and people get to enjoy producing and consuming safe and nutritious food.

References

Abdollahi, M R, B Svihus, and V Ravindran. 2013. "Pelleting of Broiler Diets: An Overview with Emphasis on Pellet Quality and Nutritional Value." *Animal Feed Science and Technology* 179 (1–4): 1–23. https://doi.org/10.1016/j.anifeedsci.2012.10.011.

Baer, Arica A, Michael J Miller, and Anna C Dilger. 2013. "Pathogens of Interest to the Pork Industry: A Review of Research on Interventions to Assure Food Safety." *Comprehensive Reviews in Food Science and Food Safety* 12 (2): 183–217. https://doi.org/10.1111/1541-4337.12001.

Brul, Stanley, Peter Coote, Suus Oomes, Femke Mensonides, Klaas Hellingwerf, and Frans Klis. 2002. "Physiological Actions of Preservative Agents: Prospective of Use of Modern Microbiological Techniques in Assessing Microbial Behaviour in Food Preservation." *International Journal of Food Microbiology* 79 (1–2): 55–64. https://doi.org/10.1016/s0168-1605(02)00179-4.

Doyle, M Ellin, and Alejandro S Mazzotta. 2000. "Review of Studies on the Thermal Resistance of Salmonellae." *Journal of Food Protection* 63 (6): 779–95. https://doi.org/10.4315/0362-028x-63.6.779.

Elsayed, Mohamed Sabry Abd Elraheam, Awad A Shehata, Ahmed Mohamed Ammar, Tamer S Allam, and Reda Tarabees. 2021. "The Beneficial Effects of a Multistrain Potential Probiotic, Formic, and Lactic Acids with Different Vaccination Regimens on Broiler Chickens Challenged with Multidrug-Resistant Escherichia Coli and Salmonella." *Saudi Journal of Biological Sciences*. https://doi.org/10.1016/j.sjbs.2021.02.017.

Goodarzi Boroojeni, Farshad, Birger Svihus, Heinrich Graf von Reichenbach, and Jürgen Zentek. 2016. "The Effects of Hydrothermal Processing on Feed Hygiene, Nutrient Availability, Intestinal Microbiota and Morphology in Poultry—A Review." *Animal Feed Science and Technology* 220: 187–215. https://doi.org/10.1016/j.anifeedsci.2016.07.010.

Den Hartog, Johan den. 2003. "Feed for Food: HACCP in the Animal Feed Industry." *Food Control* 14 (2): 95–99. https://doi.org/10.1016/S0956-7135(02)00111-1.

Jones, Frank T. 2011. "A Review of Practical Salmonella Control Measures in Animal Feed." *Journal of Applied Poultry Research* 20 (1): 102–13. https://doi.org/10.3382/japr.2010-00281.

Truelock, Courtney N, Mike D Tokach, Charles R Stark, and Chad B Paulk. 2020. "Pelleting and Starch Characteristics of Diets Containing Different Corn Varieties." *Translational Animal Science* 4 (4): txaa189. https://doi.org/10.1093/tas/txaa189.

Tugnoli, Benedetta, Giulia Giovagnoni, Andrea Piva, and Ester Grilli. 2020. "From Acidifiers to Intestinal Health Enhancers: How Organic Acids Can Improve Growth Efficiency of Pigs." *Animals* 10 (1): 134. https://doi.org/10.3390/ani10010134.

Goodarzi Boroojeni, F., W. Vahjen, A. Mader, F. Knorr, I. Ruhnke, I. Röhe, A. Hafeez, C. Villodre, K. Männer, and J. Zentek. "The Effects of Different Thermal Treatments and Organic Acid Levels in Feed on Microbial Composition and Activity in Gastrointestinal Tract of Broilers." Poultry Science 93, no. 6 (June 1, 2014): 1440–52. https://doi.org/10.3382/ps.2013-03763.