Unlocking Optimum Poultry Performance: Harnessing the Power of GH10 Xylanase

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Exogenous feed enzymes are increasingly utilized in poultry diets to manage feed costs, mitigate the adverse effects of anti-nutritional factors, and enhance nutrient digestion and bird performance. These enzymes are primarily employed to bolster the availability of nutrients within feed ingredients. Among the various enzymes utilized, those capable of breaking down crude fiber, starch, proteins, and phytates are commonly integrated into animal production systems.

In monogastric animals such as poultry and swine, a notable deficiency exists in the endogenous synthesis of enzymes necessary for the hydrolysis of non-starch polysaccharides (NSPs) like xylan (McLoughlin et al., 2017). This deficiency often manifests in poultry production as a decline in growth performance, attributed to increased digesta viscosity arising from the prevalence of NSPs in commonly utilized poultry feed ingredients. Without sufficient endogenous enzymes to degrade xylan, NSPs can increase digesta viscosity, encase essential nutrients, and create a barrier to their effective digestion. In response to this issue, monogastric animal producers have implemented exogenous enzymes such as xylanases into the feeds for swine and poultry to degrade xylan to short-chain sugars, thus reducing intestinal viscosity and improving the digestive utilization of nutrients (Sakata et al., 1995; Aragon et al., 2018)

Understanding Xylanase Enzymes

Xylanase enzymes belong to the class of carbohydrases that specifically target complex polysaccharides, such as xylan, a backbone nonstarch polysaccharide (NSP) prevalent in plant cell walls. These enzymes catalyze the hydrolysis of xylan into smaller, more digestible fragments, such as arabino–xylo-oligosaccharides (AXOs) and xylo-oligosaccharides (XOs), thereby facilitating the breakdown of dietary fiber in poultry diets.

Mechanism of action

It is generally agreed that the beneficial effects of feed xylanase are primarily due to the reduction in viscosity. Studies have shown that supplementing xylanases to animal feeds reduces digesta viscosity and releases encapsulated nutrients, thus improving the overall feed digestibility and nutrient availability (Matthiesen et al., 2021). The reduction in digesta viscosity by adding xylanase is achieved by the partial hydrolysis of NSPs in the upper digestive tract, leading to a decrease in digesta viscosity in the small intestine (Choct & Annison, 1992).

GH10 vs. GH11 Xylanases

Well-characterized xylanases are mostly grouped into glycoside hydrolase families 10 (GH10) and 11 (GH11) based on their structural characteristics (amino acid composition), mode of xylan degradation, the similarity of catalytic domains, substrate specificities, optimal conditions, thermostability, and practical applications.

Why are GH10 xylanases more efficient in animal production?

While both GH10 and GH11 xylanases act on the xylan main chain, these two enzyme types have different folds, substrate specificities, and mechanisms of action (Biely et al., 2016). The GH10 xylanases are more beneficial in animal feed production due to their efficient mechanism of action, broader substrate specificity, and better thermostability, as discussed below.

GH10 xylanase exhibits broader substrate specificity

Generally, the GH10 xylanases exhibit broader substrate specificity and can hydrolyze various forms of xylan, including soluble and insoluble substrates. On the other hand, GH11 xylanases have a narrower substrate specificity and are primarily active on soluble xylan substrates. GH10 xylanases exhibit higher catalytic versatility and can catalyze the cleavage of the xylan backbone at the nonreducing side of substituted xylose residues, whereas GH11 enzymes require unsubstituted regions of the xylan backbone (Collins et al., 2005; Chakdar et al., 2016).

As a result, GH10 xylanases generally produce shorter xylo-oligosaccharides than members of the GH11 family (Collins et al., 2005). Moreover, as shown in Fig.1, the GH10 xylanase can rapidly and effectively break down xylan molecules.

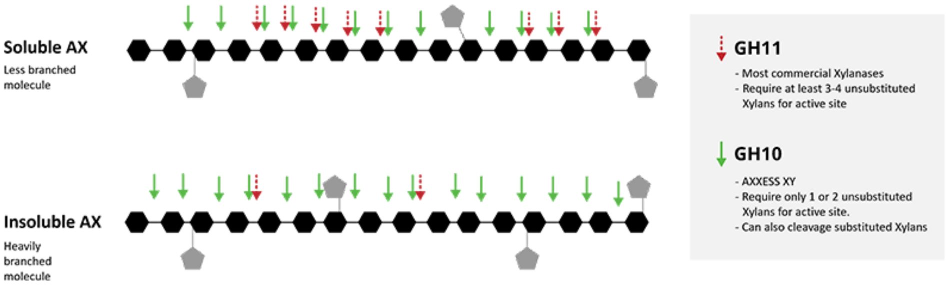

Fig.1.: Activity of a bacterial GH10 xylanase against soluble and insoluble arabinoxylans

Higher thermostability

Enzymes are proteins, and the protein’s primary structure determines their thermostability. The enzyme protein tends to denature at higher than tolerable temperatures, rendering it inactive. An enzyme’s high-temperature tolerance ensures its efficacy throughout the pelleted feed manufacturing. This results in consistent enzyme activity in the finished feed, subsequent gut health, and predictable performance benefits.

Xylanases with higher thermostability are more suitable for applications requiring high-temperature processes. An intrinsically heat-stable bacterial xylanase maintains its activity even under high-temperature feed processing conditions, such as pelleting.

A study conducted at the University of Novi Sad, Serbia (Fig. 2), with three pelleting temperatures (85 °C, 90 °C, and 95 °C) and conditioning times of 4 and 6 mins, showed that Axxess XY, an intrinsically thermostable GH10 xylanase, demonstrated more than 85% recovery even at 4 to 6 mins conditioning time and 95 °C temperature.

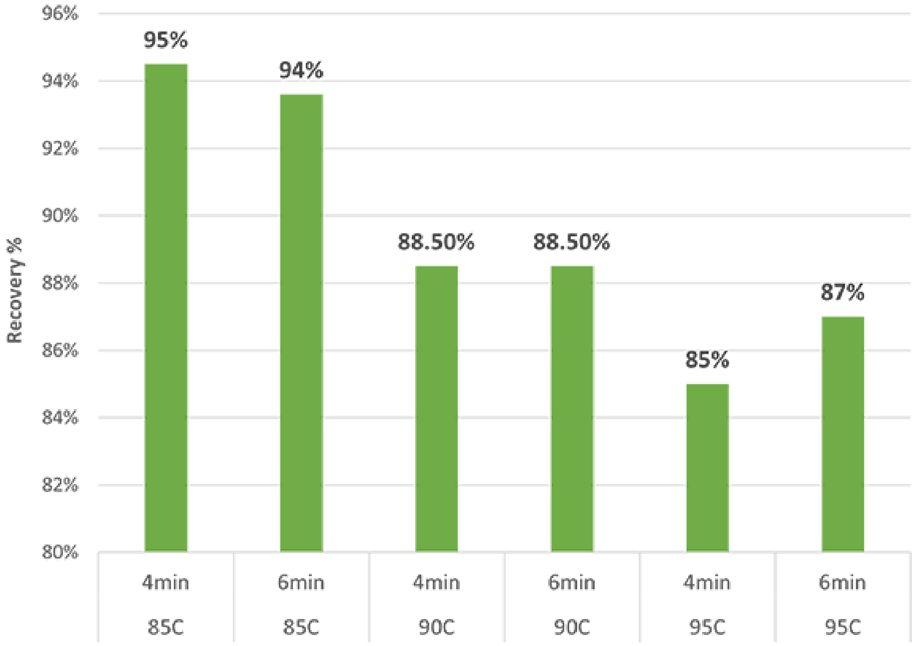

Fig.2: Optimum recovery of Axxess XY at elevated conditioning time and temperatures

Maintaining consistently optimum enzyme activity is crucial for realizing the benefits of enzyme inclusion in feed under challenging feed processing conditions.

Conclusion

In conclusion, exogenous feed enzymes, including xylanase, have gained widespread recognition for their pivotal role in poultry nutrition. The increasing use of xylanase is attributed to its ability to effectively manage feed costs while incorporating high-fiber ingredients without compromising poultry performance. However, the efficacy of xylanase is based on several factors, including its mode of action, substrate specificity, catalytic efficacy, and thermostability. Selecting the appropriate xylanase enzyme tailored for specific needs is crucial to harnessing its full benefits.

A GH10 xylanase, such as Axxess XY, designed explicitly as a feed enzyme, offers distinct advantages in poultry production. Its efficient mechanism of action, broader substrate specificity, and superior thermostability make it a preferred choice for optimizing animal performance. Notably, Axxess XY exhibits exceptional activity against soluble and insoluble arabinoxylans, thereby enhancing nutrient utilization, promoting gut health, and ultimately elevating overall performance levels in poultry.

Incorporating specialized GH10 Xylanase enzymes like Axxess XY represents a strategic approach to unlocking the nutrients in feedstuffs, ensuring optimal performance, and maximizing profitability in the poultry business.

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Exploding energy prices? Manage moisture to improve feed mill efficiency

*By **Marisabel Caballero**, Global Technical Manager Poultry, and **Ivan Ilić**, Global Manager Technical Product Applications, EW Nutrition*

Modern large-scale feed mills operate extremely efficiently and have few variable costs that could be reduced to lower the total cost of the final feed (Stark, 2012). In light of worrying energy price hikes, feed producers, however, should reduce their electricity use per unit produced, to maintain profitability. Find out how optimizing the feed mill's moisture management increases feed quality while decreasing the energy required to produce it.

Due to climatic challenges, variability in raw material quality, and technical constraints, it can be challenging for feed producers to stabilize the water content in compound feed across time, raw material batches or even different machinery.

Combined with high temperatures, high moisture in feed can favor the growth of molds. They spoil feed, depleting energy and nutrients and generating reactive oxygen species (ROS) that reduce feed palatability. Even worse, some molds release toxins harm animals' health and performance. On the other hand, low moisture levels in feed has a negative impact on pellet durability, increasing fines, process loss, and energy consumption while decreasing pellet press yield (Moritz et al., 2002).

What does feed moisture management have to do with a feed mill's electricity consumption?

Moisture from raw materias can be lost during storage and processing. Silo aeration and enviroment conditions can contribute to moisture loss when the grains are stored at higher than optimal moisture levels (Angelovič, 2018). During feed processing, the intense friction of grinding results in heat and moisture from the grains is lost as vapor. As an optimal level of moisture is critical to ensure production output and feed quality, it must be added back to the system and adequately managed to keep or increase final feed quality.

For pelleted feeds, managing moisture is a two-step process:

1. Adding moisture in the mixer. This ensures that the mash feed is enters the conditioning process at the right moisture level, facilitating the penetration of steam and increasing the efficiency of the process.
2. Managing steam during conditioning. Steam added to the conditioner must be dry (meaning saturated with water droplets in suspension), and when this dry steam contacts the feed, it condenses and adds moisture.

However, simply adding water into the mixer does not give optimal results: Pure water does not completely bind to the feed; it mostly "sits on top" of the feed surface, increasing its water activity, and thus increasing the danger of microbial growth. Plus, a high proportion of pure water evaporates again when the feed is cooled.

Surfactants improve moisture retention

Surfactants change the way water behaves: by reducing the surface tension of water, they enable the feed particles to absorb the water and ensure that it is evenly distributed throughout the feed.

Improved moisture retention can:

- facilitate the starch gelatinization during conditioning (important making the pellet more durable and the feed more digestible),
- minimize feed shrinkage,
- reduce friction and hence the energy required for the pellet die (improving milling efficiency), and
- curb microbial growth by reducing water activity.

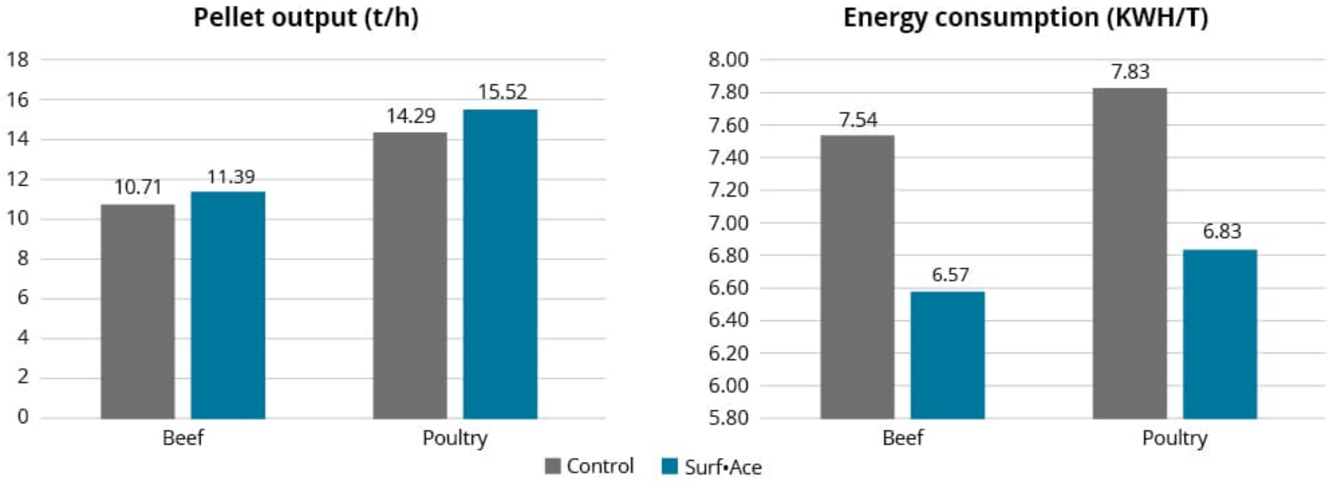
SURF•ACE: Improve throughput and reduce energy requirements

While surfactants contribute to mold control, feed producers also require the help of organic acids such as propionic acid (cf. Smith et al., 1983). The objectives are to optimize the moisture content in feed and to reduce its mold contamination. EW Nutrition's SURF•ACE^{TM} feed mill processing aid combines organic acids and surfactants to achieve the objective of adding moisture without risking either the significant loss of moisture during cooling or the development of mold.

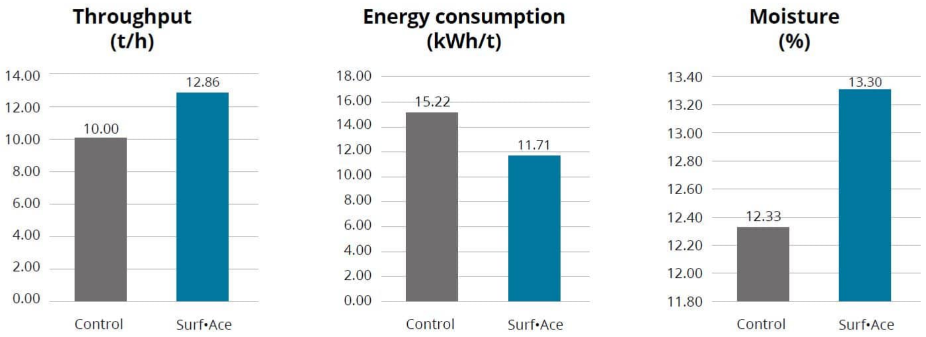
The effect of adding SURF•ACE to diets with different levels of fat was evaluated at more than 40 feed mills, with production capacities ranging from 5 to 20 tons per hour. SURF•ACE is added to water sprayed during mixing. This hydrating solution lubricates the mash feed, improves steam penetration and starch gelatinization, and reduces friction in the pellet dies. The results show that, relative to pure water, the addition of SURF•ACE increases press throughout (t/h) by between 5 and 25 %.

Trial results: SURF•ACE increases press yields while lowering energy consumption

- For a trial at a Turkish beef and poultry feed mill, the same feed was run through the pelletizer in two batches, one with a 1 % water and one with 1% water mixed with 200 g of SURF•ACE per ton of feed. Adding SURF•ACE resulted in higher pellet output (6% for beef; 9% for poutry) and reduced energy consumption (13% for both beef and poultry):



- In Poland, another trial conducted at a commercial feed mill found that when SURF•ACE was added to 1% mixer-moisture, this lead to a 28.6 % higher feed throughput in the pellet press, 23 % lower energy consumption per unit produced during the pelleting process, and a nearly 1 %-point higher moisture content in finished feed. This resulted in higher profitability: based on the costs in Poland at the time of the trial, an ROI of 2.4:1 was achieved.



- A recent trial at an Indian feed mill evaluated the difference between adding 1% moisture to produce crumble feed (control group) and upgrading the water with 200 g of SURF•ACE per ton. The addition of SURF•ACE reduced power consumption by 6% and improved throughput by 18%.

Feed mills must deal with rising energy costs head-on

Operating in a tight margin environment, feed mills always need to prioritize efficiency. The advantages of using SURF•ACE feed mill processing aid are clear: reduced energy consumption, better pellet quality, fewer fines, better PDI, moisture optimization, lower maintenance costs, and higher productivity (throughput). During times of increasingly high ingredient and energy costs, it is even more important to utilize savings opportunities at every production stage. Thanks to its dual surfactant and preservative effects, SURF•ACE enables feed mills to improve feed quality and increase throughput while lowering electricity use.

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Moisture optimization: How to

safeguard feed quality and feed mill efficiency

by Technical Team, EW Nutrition

In light of climatic challenges, variability in raw material quality and technical constraints, it can be challenging for feed manufacturers to optimize the water content in compound feed.

In combination with high temperatures, too much moisture in feed can favor the growth of mold. Molds spoil feed by depleting energy and nutrients and rendering the feed unpalatable. Even worse, some molds release toxins harm animals’ health and performance. On the other hand, too little moisture in feed has a negative impact on feed digestibility and pellet durability, increasing the level of fines, process loss and energy consumption, while decreasing press yield (Moritz et al., 2002).

In this article, we look at how the right choice of processing aid is key to sustainably boosting feed mill efficiency. A concerted focus on moisture management when preconditioning the mash feed prior to pelleting allows feed producers to reap both economic and feed quality benefits.

Why moisture management requires both surfactants and organic acids

Moisture management starts with monitoring certain indicators. The moisture content measures the total amount of water contained in a substance, usually expressed as a percentage of the total weight. Feed manufacturers track the moisture contents of raw materials, mash feed, and pellets during all processing stages to optimize quality, yields, and profitability.

For the purpose of preventing mold growth, however, another indicator is even more critical: water activity (a_w) is technically defined as the ratio of partial vapor pressure of water in a substance to the partial vapor pressure of pure water under the same temperature and pressure conditions. What this captures is the energy state of water in a substance, i.e. its potential for (bio)chemical activity, including the growth of bacteria, yeasts, and molds. Simply put, microorganisms will usually not grow below a certain water activity level, and the higher the water activity, the higher the chance of microbial growth (Roos, 2003).

Minimum water activity (a_w) for growth and toxin production of toxigenic fungi affecting grains

		Minimum a_w	
Fungal species	**Mycotoxin**	**Growth**	**Toxin production**
Aspergillus flavus	Aflatoxin	0.78 – 0.84	0.84
Aspergillus parasiticus		0.84	0.87
Aspergillus ochraceus	Ochratoxin	0.77	0.85
Penicillium aurantiogriseum		0.82 – 0.85	0.87 – 0.90
Penicillium viridicatum		0.80 – 0.81	0.83 – 0.86

Aspergillus ochraceus	Penicillic acid	0.77	0.88
Penicillium aurantiogriseum		0.82 – 0.85	0.97
Penicillium patulum	Patulin	0.81	0.95
Penicillium expansum		0.82 – 0.84	0.99
Aspergillus clavatus		–	0.99
Fusarium verticillioides	Fumonisins	0.88	0.93
Fusarium proliferatum		0.88	0.93

Adapted from Magan, Aldred, and Sanchis (2004)

Can we condition feed with pure water?

Why does this matter? The intense friction during grinding and mixing results in heat; subsequently, moisture from the mash feed is lost in the form of vapor. These losses need to be mitigated, when the feed is too dry, the milling equipment cannot function optimally and the pellet quality deteriorates. However, simply adding water does not work well: Pure water does not readily bind to the feed; it effectively “sits on top” of the feed surface, increases the feed’s water activity and thus becomes a perfect substrate for microbial growth. Plus, pure water steam largely evaporates again when the feed is cooled.

Surfactants

Hence, at the conditioning phase, it is critical to add surfactants to the hydrating solution. Surfactants change the way water behaves: by reducing the surface tension of water, they enable the feed particles to absorb the water and ensure that it is evenly distributed throughout the feed. There are numerous beneficial effects as improved moisture retention

- facilitates the starch gelatinization during conditioning (important for pellet digestibility and durability),
- minimizes feed shrinkage at the cooling stage,
- reduces friction and hence the energy required for the pellet die (improving milling efficiency), and
- curbs microbial growth by reducing water activity.

While surfactants contribute to mold control, feed manufacturers also require the help of organic acids to optimize the moisture content in feed while reliably preventing mold (re)contamination hazards along the distribution chain.

Organic acids

Let us consider how the most effective one, propionic acid, works: In its non-dissociated state, propionic acid has all its hydrogen ions attached to the molecule. Once it enters a mold cell, the propionic acid dissociates, meaning the hydrogen ions separate from the molecule. They reduce the intracellular pH in the mold cell and inhibit its metabolic pathways, ultimately leading to cell death (Smith et al., 1983).

Common feed ingredients such as soybean meal, maize, wheat, barley, and dehulled oats are often stored for several months. Given variable and likely challenging temperature, oxygen, and moisture conditions, their water activity levels can easily escalate (Mannaa and Kim, 2017) – rendering the long-lasting anti-fungal activity of targeted organic acid preconditioning even more important.

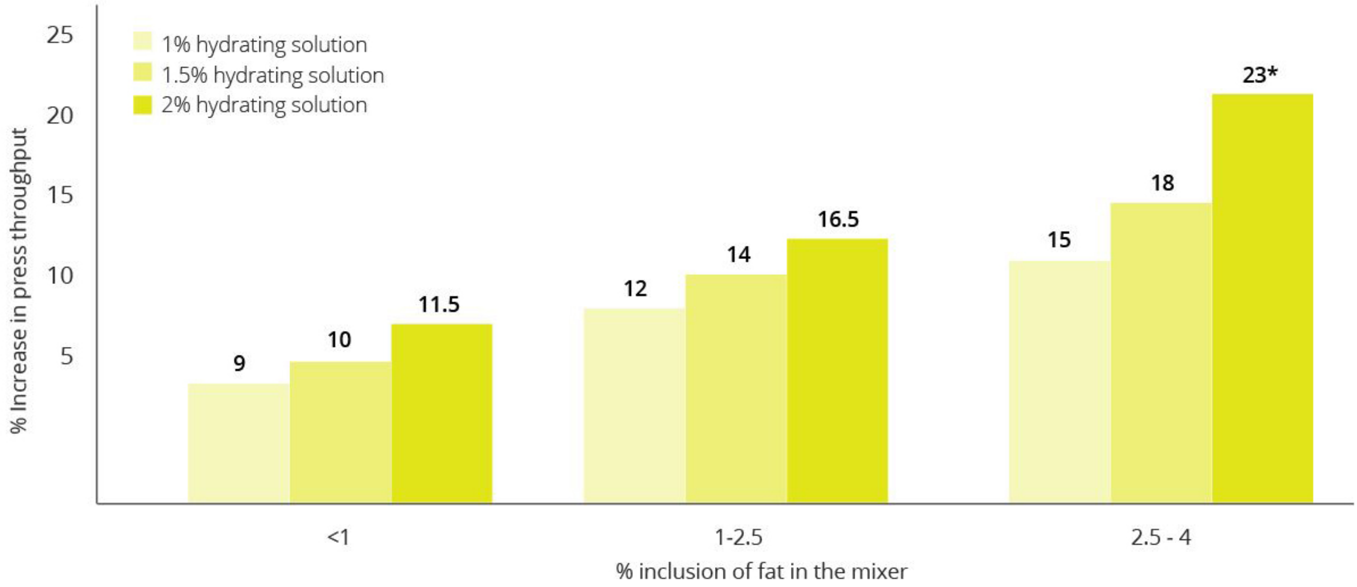
SURF•ACE: Improve mill performance and pellet quality

A synergistic blend of organic acids and surfactants can achieve the objective of adding moisture without risking either the subsequent loss of moisture during cooling or the development of mold. This is the working principle behind SURF•ACE^{TM} feed mill processing aid, carefully formulated to best achieve the dual objective of higher feed quality and higher production efficiency. This objective is achieved in concordance with optimal resource use and lower energy requirements, thus also contributing to the feed industry’s environmental commitments.

Improved press yield

The effect of adding SURF•ACE to diets with increasing levels of fat were evaluated at more than 40 feed mills, with production capacities ranging from 5 to 20 tons per hour, under identical electricity consumption conditions. The results show that the addition of SURF•ACE to the preconditioning solution increases press throughout (t/h), relative to pure water preconditioning, by between 9 and 23 %, depending on how much preconditioning solution is applied and the level of fat in the diet:

Addition of SURF•ACE increases press throughput



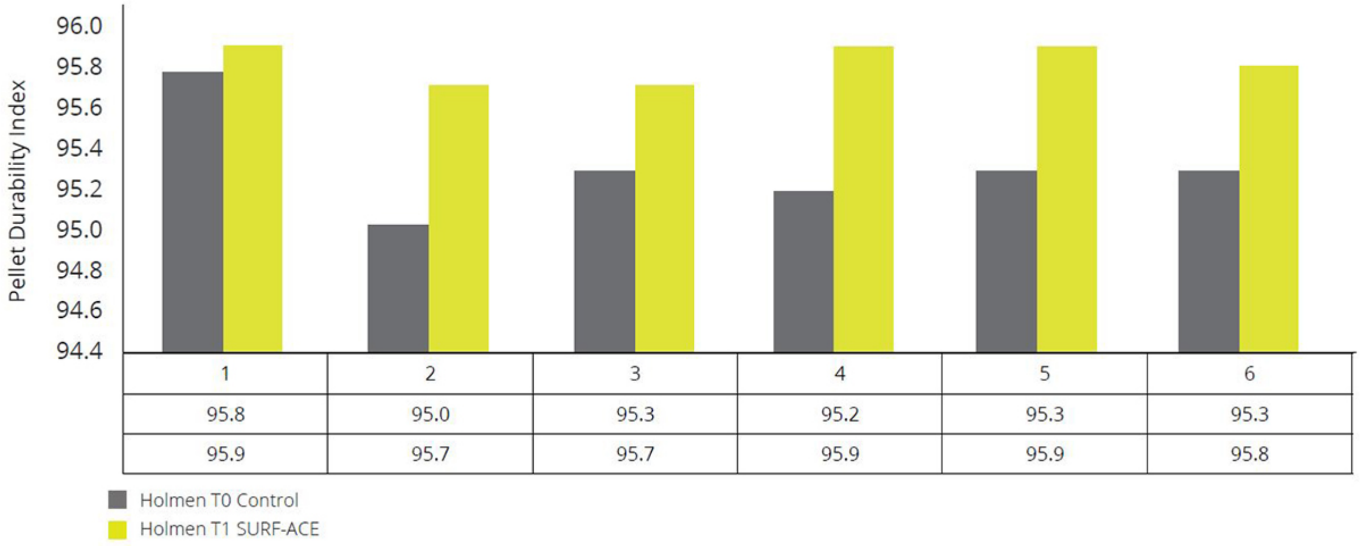
**Including large volumes of hydrating solution in high-fat diets might adversely affect the durability values of the feed*

What is the role of fat in this scenario? Dietary fat acts as a lubricant between the feed and the pellet die, reducing the pressure within the die. The higher the percentage of fat included in the mixer, the lower the energy required to process the mash (Pope, Brake, und Fahrenholz, 2018). The surfactants contained in SURF•ACE have an emulsifying effect; they help bind water to the fat element of the feed. The emulsion of water and fat “behaves” like fat, improving the lubrication of press and generating a higher throughput for the same electricity consumption.

Higher pellet quality

Importantly, adding SURF•ACE does not negatively affect pellet durability, a common issue in high-fat diets (Moritz et al., 2003). On the contrary, it enhances pellet durability as more crystal starch becomes gelatinized. This translates into improved results for Holmen pellet durability testing:

Addition of SURF•ACE improves pellet durability



1	2	3	4	5	6
95.8	95.0	95.3	95.2	95.3	95.3
95.9	95.7	95.7	95.9	95.9	95.8

Pellets need to withstand significant pneumatic handling, for example, during bagging and transport, and in the feed lines. The Holmen durability tester simulates this handling, and calculates the percentage of fine generated, expressed as a pellet durability index (PDI). Across six different poultry compound feed types, SURF•ACE improves pellet quality and thus the PDI. Fewer fines equate to less reprocessing for feed manufacturers and higher palatability for animals.

The next level in compound feed production

Achieving optimal moisture levels in compound feed is a complex balancing act involving technical constraints, raw material variability, microbial challenges, and the price pressures of competitive feed markets. Feed mills generally operate within a particular comfort zone, a throughput and quality level at which they minimize production problems. Thanks to its dual surfactant and preservative effects, SURF•ACE feed mill processing aid expands the comfort zone in two dimensions: From an economic point of view, the improved lubrication gives mills the choice of either pushing their performance levels closer to their equipment's potential capacity or achieving the same results at lower electricity use. From a feed quality angle, effective mold prevention and improved pellet quality allow for safer, more palatable feed – and from there we come full circle, to safe, nutritious food for all of us.

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