



ProPhorce™

Making a difference in acidification
and bacterial inhibition

Feed additives that give key benefits

- ➔ Strong effect against harmful bacteria
- ➔ Effective at high and low pH levels
- ➔ Improved digestibility of nutrients
- ➔ Enhanced hygiene along the feed chain
- ➔ Strong reducing effect on pH

Highly effective acidifiers and antibacterials

The microbial contamination of feed can have a significant negative economic impact on animal performance. This expresses itself in many forms:

- ➔ Reduced nutritional value of feed
- ➔ Post-weaning diarrhea in piglets
- ➔ Poorer health status of animals

Pathogenic bacteria not only decrease animal performance but may also find their way into food processing for human consumers. Therefore it is crucial to minimize these threats to animal and human health, as well as safeguarding animal performance and productivity.

Higher net profit

The following is an example of how an acidifier can boost profitability for a poultry farm.

Standard breeder feed, cost/tonne	€ 280
Acidifier, dry, cost/kg	€ 2.20
Dosage level/tonne	3 kg
Application cost/tonne	€ 6.6
Breeder feed+acidifier/tonne	€ 286.6

Dedicated feed additives

Perstorp first introduced formic acid as a feed additive during the 1960's. Then, in the light of experience and many feed trials, other acidifiers that could inhibit a wide range of micro organisms were launched.

Today, ProPhorce™ feed additives from Perstorp include a number of dry and liquid products that are dedicated to acidification and bacterial inhibition. They consist of either organic acids or organic acids mixed with essential oils. Their properties have been investigated and product formulations have been developed to ensure you achieve optimal results.

Individual additives are tailored to inhibit bacterial growth in general or particular pathogenic genera like *Salmonella*, *E. coli*, *Clostridium* and *Campylobacter*. Some additives even provide a highly digestible source of calcium.

Choosing the right ones

The ProPhorce™ feed additives developed to make a difference in bacterial inhibition and acidification are presented below. They are grouped into three application areas:

- ➔ Acidifiers (ProPhorce™ AC)
- ➔ Antibacterials (ProPhorce™ PH and ProPhorce™ BD)
- ➔ Anti-salmonella agents (ProPhorce™ SA)

You can obtain detailed information on product properties, application and efficacy from our application specialists or our website: www.perstorpfeed.com

	No acidifier	With acidifier
Feed intake, kg/breeder	42.68	42.72
Feed cost/kg	€ 0.28	€ 0.287
Total feed cost/breeder	€ 11.95	€ 12.24
Mean number of chicks/breeder	124.71	132.61
Value per chick	€ 0.27	€ 0.27
Total income	€ 33.67	€ 35.80
Difference		€ 2.13 extra income = € 1.84 net extra income per breeder

If 10 000 breeders per hen house, the extra profit per hen house is $10\,000 \times € 1.84 = € 18\,400$

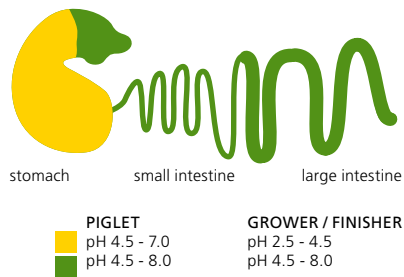


ProPhorce™ acidifiers

Acidifiers, such as the ProPhorce™ AC range primarily consist of one or more organic acids and are used to lower the pH in feed and the stomach of farm animals, particularly piglets. Animal trials have shown that a lower stomach pH provides the following benefits:

- ➔ Improved digestibility of nutrients (Gabert & Sauer 1995)
- ➔ Prevents growth of harmful bacteria (Kircheggner et al, 1992)
- ➔ Stimulates enzyme activity (Colin and Dykes, 1976)
- ➔ Lowers feed buffering capacity (Overland, 2000)

In piglets, the secretion of acid into the stomach after weaning is insufficient to lower the pH to a level that is optimal for digesting compound feed. The pH levels in the gastrointestinal tract (GIT) of piglets and growers/finishers are shown in the diagram.

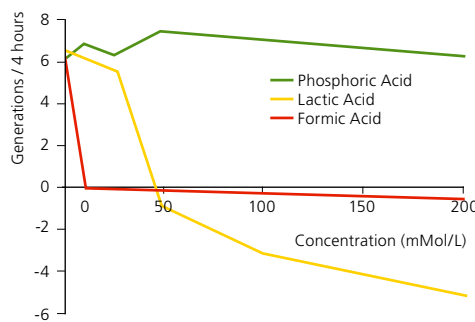


The pH in the gastrointestinal tract of pigs

In addition, diet acidification lowers feed buffer capacity and stomach pH. This results in a slow release of chyme into the duodenum, thereby stimulating the pancreatic enzyme release, which gives better nutrient digestibility (Chin et al, 1992).

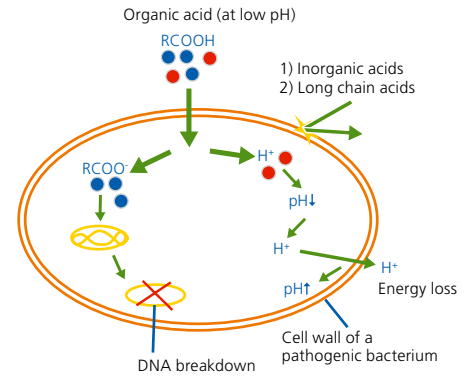
Antibacterial activity

ProPhorce™ acidifiers exhibit strong antibacterial activity against *E. coli* and other pathogenic bacteria. These bacteria are a major cause of diarrhea. The antibacterial activity of three organic acids can be seen in the following graph.



The antibacterial effect of formic, lactic and phosphoric acid on *E. coli* at pH 5 (CCL, 1995).

The organic acids in ProPhorce™ acidifiers are able to enter the cells of pathogenic bacteria at low pH and destroy them, unlike inorganic acids.



An organic acid passes through the cell wall and breaks down DNA and lowers pH. The cell tries to keep the internal pH neutral by actively transporting H⁺ out of the cell. This causes a substantial loss of energy that results in cell breakdown.

ProPhorce™ organic acid salts

ProPhorce™ organic acid salts are manufactured with highly digestible minerals and acids. The nutrients are delivered to those parts of the animal gastrointestinal tract where they are needed most. The calcium in our calcium salts has a very high biological availability. Our ProPhorce™ organic salt products are free-flowing and can be easily used in premixes.



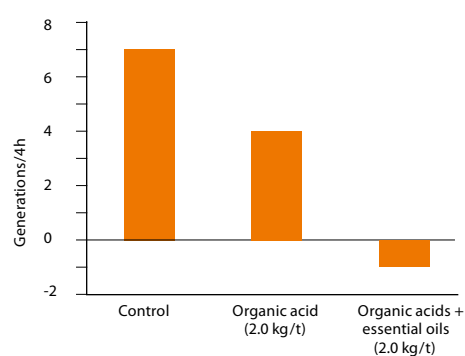
ProPhorce™ antibacterials

An important difference between Perstorp's range of ProPhorce™ acidifiers (ProPhorce™ AC) and ProPhorce™ antibacterials (ProPhorce™ PH and ProPhorce™ BD) is that the latter contain a mixture of organic acids and essential oils.

Although ProPhorce™ antibacterials are used in a similar way to our acidifiers, scientific research has shown that essential oils confer important added value through:

- ➔ Having a stronger antibacterial effect due to their synergistic effect with organic acids
- ➔ Being effective at high and low pH levels

The synergistic effect of organic acids and essential oils in ProPhorce™ antibacterials on the reduction of *E. coli* at pH 6 can be seen in the following graph.



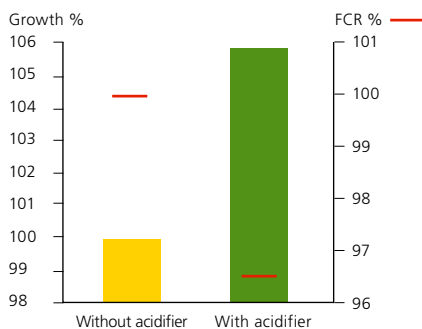
Synergistic effect of organic acids and essential oils in ProPhorce™ antibacterials on the reduction of *E. coli* at pH 6 (RAP-1002024 E).

Antibacterial activity

Certain ProPhorce™ antibacterials (ProPhorce™ PH and BD) were developed specifically to combat problems with pathogenic bacteria found along the feed chain, particularly on farms. Harmful bacteria such as *Clostridium*, *Campylobacter* and pathogenic strains of enteric bacteria like *E. coli* can cause severe illness and even death in both human hosts and farm animals at great economic cost. Therefore dedicated ProPhorce™ antibacterials are an important weapon in the arsenal directed at combatting pathogens and raising standards of hygiene.

ProPhorce™ in practice

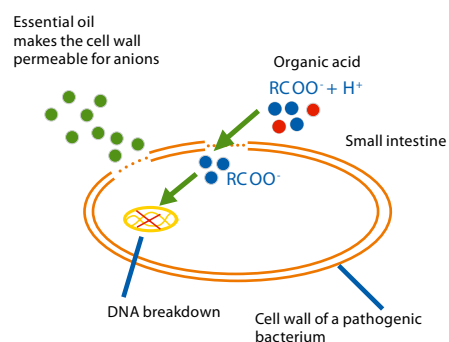
Trials commissioned by Perstorp have shown better growth and an improved FCR in piglets fed a diet containing an acidifier (FPI-2005-1).



Growth and FCR (after 4 weeks) in piglets fed on a diet containing an acidifier.

Mode of action

The inhibitory action of ProPhorce™ antibacterials is similar to that of ProPhorce™ acidifiers, but at high pH levels the essential oil can make bacterial cell walls permeable to organic acid anions, which can carry out their destructive activity within bacterial cells.



Synergistic effect of organic acids and essential oils in inhibiting pathogenic bacteria at high pH.

At higher pH levels an organic acid will dissociate ($RCOO^-$ and H^+) and normally the ions cannot enter bacterial cells. However, certain essential oils make the cell wall permeable to these ions at higher pH levels, thereby enabling the organic acids to be more effective throughout the whole GIT (Zhou et al, 2007).

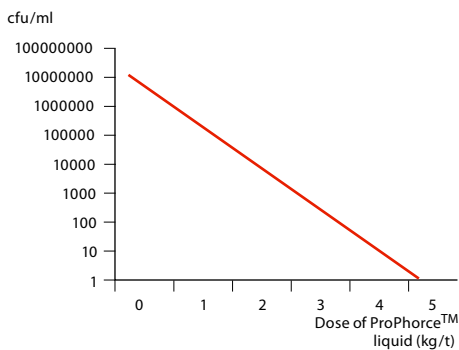


ProPhorce™ anti-salmonella agents

The ProPhorce™ product range includes a complete program (ProPhorce™ SA) for preventing and inhibiting the growth of *Salmonella* in feed ingredients and compound feed. This anti-salmonella program provides the following advantages:

- ➔ Rapid reduction of salmonella bacteria
- ➔ Prevention of recontamination
- ➔ Highly concentrated products with long-term effect
- ➔ Economical anti-salmonella solutions

The success of the ProPhorce™ anti-salmonella range results from their unique combination of organic acids that give a powerful long-term synergistic effect. Their mode of action is described under “ProPhorce™ acidifiers”, and their efficacy against *Salmonella typhimurium* is shown in the following graph.



In vitro effect of a ProPhorce™ anti-salmonella agent on a highly contaminated medium of *Salmonella typhimurium*.



As *Salmonella* is sensitive to heat, using heat treatment during feed production is one way of reducing the number of this pathogen, although it is not 100% effective. The remaining salmonella bacteria cause recontamination of the feed at a later stage, thus emphasizing the value of using ProPhorce™ anti-salmonella agents to reduce this problem wherever animal feed is involved.



{innovation}



An innovative leader in the feed additive market

For over fifty years Perstorp has been involved in developing a range of highly effective feed additives. Perstorp was one of the first companies to introduce acid-based silage additives to the market in the 1960s, and pioneered the use of lactic acid in formulas for acidifiers and antibacterials in the 1980s.

Today, the range, quality and properties of our feed additives make a real difference in helping you to become more competitive. As a world leader in this area, we aim to keep it this way.

Maintaining feed value

There are a number of ways that Perstorp feed additives maintain the nutritional and economic value of feed:

- ➔ Inhibiting microbial growth to preserve the nutritional value of feed.
- ➔ Specifically inhibiting the growth of pathogenic bacteria such as *Salmonella*, *Campylobacter* and *E. coli*.
- ➔ Prolonging shelf-life.
- ➔ Improving the digestibility of nutrients.
- ➔ Stabilizing feed ingredients.



Our "Pro" lines for professionals

The core product lines and benefits of Perstorp feed additives are:

ProSid™

Mould inhibitors, toxin binders and immune stimulants for preventing and overcoming mould-related problems.

ProMyr™

Silage additives for the preservation of nutrients, minimizing bacterial spores and increasing the storage life of roughage

ProPhorce™

Acidifiers, antibacterials and feed preservatives for inhibiting the growth of pathogens and improving the digestibility of nutrients.

ProFare™

Enzymes for increasing the digestibility of feed and the nutritional value of feed ingredients.

ProTain™

Antioxidants for stabilizing feed ingredients and prolonging product shelf-life.

An extensive program of customer care

As our product knowledge is complemented with thorough technical support, you can depend on us for your feed needs. Perstorp employs several application specialists to promote good customer care through personal contact, discussing relevant feed topics, and following up our activities with you.

As we like to form a partnership with you, we do our best to satisfy your feed additive requirements and foster long-term relationships. Through our unique raw material position and know-how with formic acids, formates, propionic acids and propionates, we are able to continue developing cost-effective customer solutions.

When you choose Perstorp as your partner, we strive to safeguard your investment.





Your Winning Formula

The Perstorp Group is the world leader in several sectors of the specialty chemicals market. Few chemical companies in the world can rival its 130 years of success. Today we have a rich performance culture distilled from our long history and extensive knowledge in the chemical industry. That culture and knowledge base enables us to produce Winning Formulas for a wide variety of industries and applications.

Our products are used in the aerospace, marine, coatings, chemicals, plastics, engineering and construction industries. They can also be found in automotive, agricultural feed, food, packaging, textile, paper and electronics applications.

Our production plants are strategically located in Europe, North America and Asia and are supplemented by sales offices in all major markets. We can offer you speedy regional support and a flexible attitude to suit your business needs.

If you want a partner for feed additives who can offer you focused innovation to enhance your product or application, which is delivered reliably and responsibly, look no further. We have a winning formula waiting for you.