

Betaine supplementation for better pig productivity

Natural betaine, obtained from sugar beet, has been long known to offer significant performance benefits to commercial animal producers. For pigs, especially the youngest ones, the compound works as an osmolyte and as a methyl donor.

Betaine can be extracted from the sugar beet plant.

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Betaine can best be described as a trimethyl derivative of the amino acid glycine which naturally occurs in relatively large quantities in aquatic invertebrates and sugar beet. How do the modes of action of the natural form of betaine, extracted from sugar beet molasses and vinasses, deliver particular benefits at key production stages? And how does the natural form of betaine add more value than its synthetic counterpart?

Two ways

To understand how betaine can add value to feed, it's important to understand its two key functions:

- **As an osmolyte** – betaine's dipolar structure and charge neutrality allows it to readily form hydrogen bonds with water. As it is easily absorbed, natural betaine is able to effectively increase the osmotic con-

centration within cells. Less energy is used by the animal as water volume is maintained without increasing ion levels inside the cell. Enzyme and protein structures within cells can therefore be maintained and they can continue to function normally without being osmotically disturbed.

- **As a methyl donor** – methyl groups are required for the synthesis of numerous substances. These include:
 - Creatine and carnitine – important for energy production;
 - Phospholipid molecules – essential for cell membrane and nerve health;
 - Purine and pyrimidine – used in the production of DNA;
 - The stress hormone epinephrine;
 - DNA methylation.

Methyl groups are also essential to the basic functioning of the immune system. There are three prospective methyl donors that can provide methyl groups in the trans-methylation cycle, an essential process in an animal's metabolism:

- **Betaine** is a highly efficient methyl donor that directly donates a methyl

group to convert homocysteine to methionine (an essential process for the regeneration of methionine).

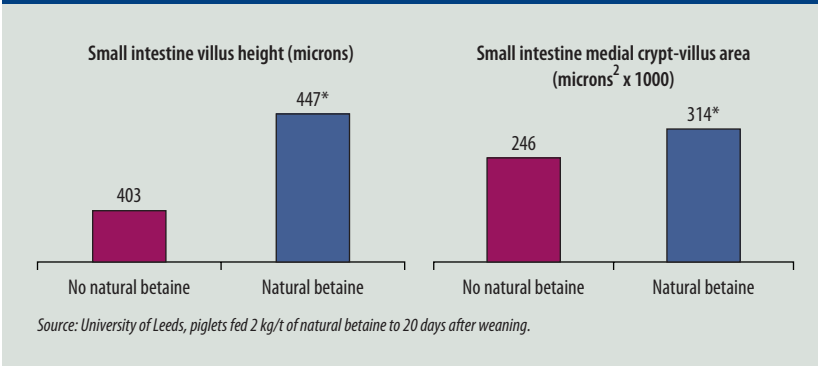
- **Choline** is required for synthesis of compounds such as membrane phospholipids and the neurotransmitter acetylcholine. Choline can also be a methyl donor but only after conversion to betaine. This conversion is only around 55% efficient.
- **Methionine** is used for protein synthesis and can also act as a methyl donor after conversion to S-adenosyl-methionine (SAM).

Both choline, chloride and methionine are routinely added to animal feeds but natural betaine is the most biologically efficient and cost effective way of supplying these methyl groups.

The natural choice

Betaine's dual mode of action adds value from conception, gestation and lactation through to grow-finisher stages. During weaning, dehydration caused by physiological stress is a major challenge for producers. Through its mode of action as an

Figure 1 - Natural betaine significantly improved ($P < 0.05$) muscle depth and tensile strength in the small intestine – means a more robust gut structure for improved digestion and absorption after weaning.



osmolyte, natural betaine enhances water retention/absorption and reduces energy costs through its positive effects on water and ion balance in cells.

As an osmolyte, it is also particularly effective in boosting energy during the hot summer months when fertility in sows can be depressed.

Research has also shown that the addition of natural betaine can lead to improvements in the tensile strength of the gut, which can be weakened by challenges such as heat stress. When ambient temperature increases, blood flows preferentially to the skin in order to release heat. This reduces blood flow to the gastro-intestinal tract, which in turn leads to impaired digestion and reduced nutrient digestibility.

Stress can result in changes in gut structure of growing pigs, which can impact gut strength if left unchecked. Natural betaine supplementation has positive effects on both the gut structure and the animal's immune system. Its gut integrity benefits can help protect the animal against dehydrating conditions associated with situations such as coccidiosis or the proliferation of other undesirable micro-organisms in the gut, which can contribute to poor performance.

An additional production benefit of increased gut tensile strength is minimisation of intestinal breakage and the likelihood of digesta spillage onto the carcass during processing at the slaughterhouse when the gut is removed.

In addition, betaine's contribution to methylation requirements adds significant production value. Sow supplementation can help reduce conceptus loss, improve sub-optimal reproductive performance and increase litter size in the subsequent

parity. It also spares maintenance energy in pigs of all ages, leaving more metabolic energy for carcass lean gain and improving animal vitality. This benefit is particularly key during weaning when maintenance energy requirements are higher.

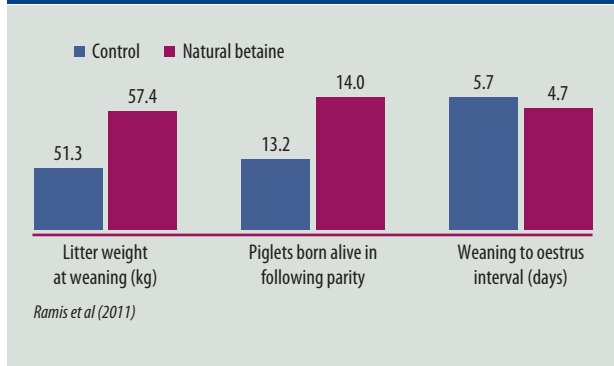
Natural betaine's positive impact on performance makes it extremely valuable in markets like the US where the pig inventory has been hit by the Porcine Epidemic Diarrhoea (PED) virus outbreak and the current weaned pig value is over \$50 per sow. Fast, early growth is economically valuable – each extra kg of growth around weaning will also reduce production cycles by four to five days. Nutritionists should also look at the availability of support tools to ensure that betaine dosing supports the accurate, and safe replacement of costly methionine and choline in order to save money while improving performance.

Natural vs synthetic betaine

Chemically synthesised betaine products that claim similar bio-efficacy to natural betaine, such as betaine hydrochloride (HCl), have been shown in recent studies to show significant differences in performance.

The differences were particularly pronounced when osmolytic functionality was compared. For betaine to function as an efficient osmolyte *in vivo*, it is important that it dissolves in water rapidly and completely. Comparative studies have shown that natural betaine is approximately three times more soluble and that it dissolves in water more than twice as rapidly as betaine HCl. The low water solubility of betaine HCl can reduce cellular uptake of the betaine component, reducing its ability to function as an osmolyte and methyl

Figure 2 - Natural betaine significantly ($P < 0.05$) increased litter weight at weaning and piglets born alive in the following parity and reduced weaning to oestrus interval.



donor. Betaine HCl's high chloride content can also disrupt cellular water balance and interfere with betaine's key osmolytic function, leading to wet litter and poorer performance.

Further studies using an *in vitro* intestinal cell model have shown that betaine HCl negatively influenced the gut barrier, significantly reducing transepithelial electrical resistance values and reducing the ATP content of cells when compared to natural betaine. Weak cellular tight junctions between gut epithelial cells can lead to movement of antigens across the gut barrier to provoke a damaging and energetically costly inflammatory response. Betaine-HCl also increased cell inflammation compared to both the control and natural betaine groups, as indicated by significantly higher cytokine IL-8 production.

Proven profitability

In summary, there is a large body of evidence supporting the significant role of betaine in pig diets. Research also shows the benefits of using natural betaine versus the synthetic form.

Improved carcass composition, increased lean growth, reduced maintenance energy requirements, improved tolerance to heat stress and support of gut structure are some of the primary benefits shown in natural betaine trials. The fact that these benefits have been demonstrated in sows, piglets and grower finishers suggests a wide application across the pig herd and leaves little doubt that natural betaine application can help improve pig performance and reduce production costs. **PP**

References and more available on request from monica.hart@dupont.com