Natural Betaine in Pig Diets – A better start & better finish

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INTRODUCTION

Dietary betaine acts both as an osmolyte, reducing the pig's energy demands to maintain cellular water and ion balance, and as a methyl donor. This can save on dietary methyl donors such as methionine and choline, both providing opportunities to reduce feed cost.

Reducing animals' maintenance requirement through improved osmo-protection effectively frees some feed energy for lean meat growth. As 40-50% of maintenance energy goes in meeting the demands of the gut and other visceral organs, then even small reductions in maintenance requirements can have dramatic effects on pig performance, as more energy is available for lean meat growth. Improving osmotic balance in the cells lining the intestines can also aid nutrient absorption and can contribute to more consistent pig performance.

To understand the role of betaine in the feed, and its metabolism, an understanding of molecular structure is required **(Figure 1)**. Each betaine molecule has three methyl groups that are labile, and allow it to function as a methyl donor in metabolism. The second key point to consider is that the betaine molecule has both a positive and negative charge, which means it is non-perturbing to cellular metabolism when accumulated to high levels. This, along with other factors, gives it the characteristics of an osmolyte, meaning that it can help the animal maintain water balance inside its cells, and reduce maintenance energy requirements during this whole process.

Although the benefits of betaine to the animal are numerous, essentially all of these have their origin in either the methyl, or the osmolytic capabilities of the molecule.

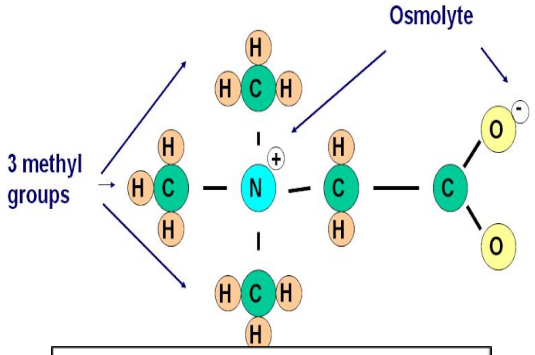

Figure 1. Structure of the Betaine Molecule

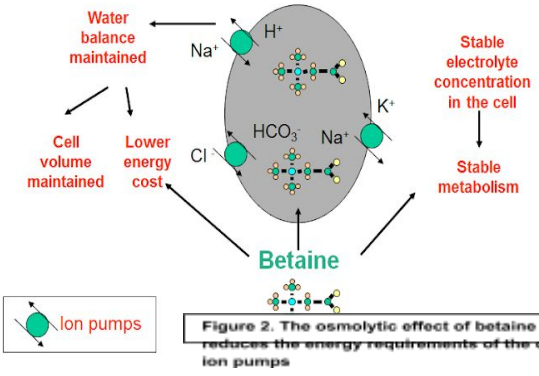

Figure 2. The osmolytic effect of betaine reduces the energy requirements of the cells ion pumps

By providing supplementary betaine, and increasing intra-cellular betaine concentrations, there is a reduced need for cells to pump ions to maintain osmotic balance, thus effectively reducing the maintenance energy requirements of the animal **(Figure 2)**.

This effect has been well demonstrated in swine especially when we remind ourselves of the importance of maintenance energy requirements to daily energy needs. A pig's visceral organs comprise 40 – 50% of total maintenance energy demand, and within this the Na/K pump mechanism (**Figure 2**) contributes 30 – 60% of the energy consumption in the gut epithelium and the liver. Disease challenges, heat stress, and less digestible ingredients are all likely to increase the maintenance energy requirement for ion pumps. It has been estimated, for example, that maintenance energy sparing due to dietary betaine was approximately 10% of total maintenance energy, or around 3% of total dietary energy in pigs.

In situations where environmental heat stress is experienced, the beneficial effects of betaine's osmotic properties become particularly apparent. Betaine can help maintain water balance in all cells but is used as a methyl source in the liver of farm animals and, in some species, in the kidney. So, importantly, it is possible to obtain both methyl and osmotic benefits of betaine from the same inclusion.

An improvement in the lean growth of pigs with betaine supplementation has been demonstrated in several trials. This effect is likely to be from a combination of the osmolytic and methylation functions of betaine. The osmolytic functions relate to both the level of hydration affecting the activity of the muscle cells, as well as decreased maintenance energy costs leaving more energy available for growth and lean gain, assuming sufficient availability of amino acids. It needs to be borne in mind that dissected lean muscle is essentially 70 – 75% water, and thus the effect of an osmolyte will tend to increase muscle mass. The methylation capacity of betaine results in uplifted production of creatine and carnitine in the liver as well as a higher RNA to DNA ratio in the muscle, indicative of increased protein synthesis.

Data from 5 trials showed benefits in daily gain, FCR, lean gain, and lean gain: feed intake with betaine inclusion in the diet **(Figure 3)**. This data also confirmed the expected higher responses when dietary energy intake was limiting.

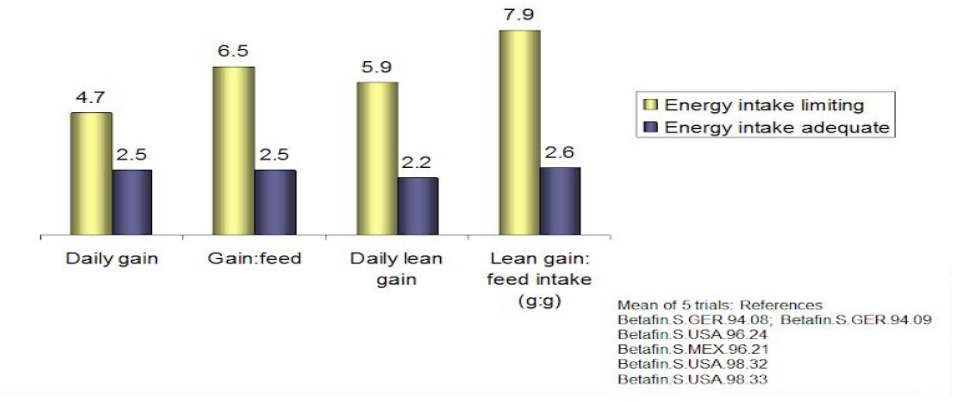

Figure 3. Responses (%) in daily gain, gain: feed, daily lean gain, and lean gain: feed intake with dietary addition of betaine in situations where dietary energy intake was limiting, versus adequate dietary energy intake.

Improvements in loin eye area, as well as eye muscle thickness have been shown across several trials. An average back-fat reduction of 12% was also demonstrated across six trials and two commercial data

sets. Bunge also noted a 14% reduction in P2 fat thickness, whist simultaneously finding a marked reduction in the variability of this parameter within the pigs when supplemented with dietary betaine.

HEAT STRESS REDUCTION WITH NATURAL BETAINE - Cronje (2006) suggested that exposure to heat results in redistribution of blood to the periphery of the body and compensatory reduction in the blood supply to the gut, which damages the cell lining of the gut permitting endotoxin to enter the body. This effect is potentially enhanced in production livestock where energy dense diets are known to cause damage to the gut lining. In summary, the osmolytic benefits of betaine not only ameliorate performance losses in heat stressed animals, but also render them more resilient to episodes of heat stress. This effect is likely to be largely driven by increased water holding capacity of the cells at an intestinal level, reducing the overall maintenance energy requirement of the gut and improving its functionality.

BENEFITS OF NATURAL BETAINE IN THE YOUNG PIG - The young pig faces several challenges after weaning, including: 1.) dehydration, 2.) changes in gut structure which can reduce nutrient digestibility and provide more substrate for bacteria, 3.) the release of toxins in the gut by pathogenic bacteria disturbing water balance, and 4.) the potential for coccidiosis which can contribute to poor performance. Work done at the University of Leeds, demonstrated significant improvements in the gut absorptive area and gut structure with pigs fed a dietary inclusion of betaine to 20 days post weaning. A large amount of research has been done in the poultry industry to show the benefits of dietary betaine when coccidiosis challenges are experienced. Reductions in coccidial related lesions, improvements in gut tensile strength, and improved villus height were identified as the primary factors in this response.

BENEFITS OF FEEDING NATURAL BETAINE TO SOWS - Three consecutive trials at Bunge Meat Industries with 120 – 160 sows in each trial showed consistent increases of approximately 1.2 piglets born alive where dietary betaine was included in the sow's lactation diet at a rate of 2kg / tonne. This translated in to an increased no. of pigs weaned per sow. It was also noted that the milk of the sows fed dietary betaine increased markedly in its betaine concentration versus a control diet. It is thus likely that the intake of this betaine enriched milk from the sow will result in several of the benefits previously described in the young pig.

A more recent trial conducted at a research facility in Spain confirmed a significant increase in piglets born alive from the second parity onwards, as well as pigs weaned per sow. The betaine content of the sow's milk in this trial was also higher versus the control sow treatment. Van Wettere *et al* (2012), had similar findings, demonstrating a significant increase in litter size for sows in their 3rd, and subsequent parities where betaine was included in the sow gestation diets during summer in Australia. Based on the available literature, it is suggested that betaine supplementation could have increased conceptus survival through any or all of three mechanisms: 1.) Reduced homocysteine concentrations due to altered methionine metabolism, 2.) Increased efficiency of energy utilisation, and / or 3.) Increased growth hormone secretion.

CONCLUSION

In summary, there is a large body of research supporting the significant role of betaine in pig diets. Improved carcass composition, increased lean growth, reduced maintenance energy requirements, improved tolerance to heat stress, and maintenance of gut health (especially under challenge conditions), are some of the primary benefits that have been shown in trials. Demonstration of these benefits in sows, younger pigs (post-weaning), and growing-finishing pigs suggests a wide application for betaine throughout the pig herd.

Reference available on request.