Use of Betaine in Pig Production

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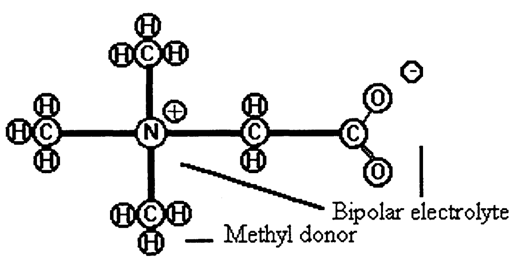
The use of betaine as a substitute for choline chloride as a methyl donor has been recognised for quite some time. Work conducted by Saunderson and Mackinlay (1990) which showed that betaine supplementation reduced and/or redistributed carcass fat in broilers initiated collaborative work between Finnsugar Bioproducts, Its Australian representative Tall Bennett and Bunge Meat Industries on betaine supplementation in pigs showed that betaine could possibly reduce backfat in pigs. This provoked a major investigation into the role betaine may play in fat and protein metabolism.

Betaine (5-methyltetrahydrofolate) is a naturally occurring compound that plays a role in metabolism as a methyl donor and as an osmoprotectant. The chemical structure of betaine is shown in figure 1.

Figure 1 Betaine Molecule



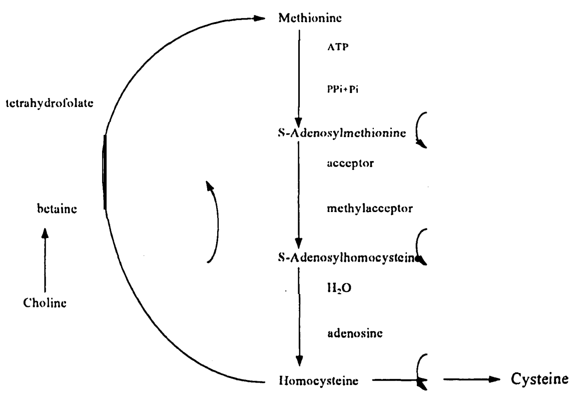
The bipolar nature of betaine helps it to act as an osmoprotectant which has shown to be very important for gut integrity in broilers under coccidiosis challenge. This osmoprotectant role may also be important for weanling pigs to help overcome stressors that may effect gut integrity. Trials to date have been inconclusive with the level of stress imposed on the piglets varying considerably between trials.

To date the attributed function of betaine is as a methyl donor in the metabolic reaction for conversion of homocysteine to methionine. The metabolic reaction is shown in figure two. this reaction is the pathway involved in transforming methionine into cysteine. Little attention has been focus on the conversion of homocysteine back to methionine but it may play a larger role than previously imagined. Choline can act as methyl donor in this reaction but it must first be converted to betaine which is a major rate limiting step in the mitochondria. Betaine in this case is a five times more potent methyl donor than choline.

The methylation ability of betaine has also been attributed to lipotrophic effects where betaine stimulates liver lipid mobilisation altering favourably the blood lipoprotein profile, the stimulation of camitine synthesis and therefore increased fatty acid oxidation in the mitochondria.

The first indepth experiment conducted at Bunge

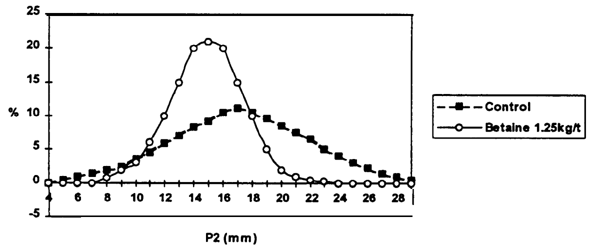
Figure 2 Metabolic pathway between methionine and homocysteine



Meat Industries research facility by Cadogan et al (1993) showed how betaine significantly decreased P2 fat thickness in the carcass by 14.8% and also changed the variation in P2 between animals.

The experiment involved two groups of twenty crossbred female pigs allocated at 60kg to a basal diet supplemented with 0 and 1.25kg betaine/tonne. The pigs were fed adlibitium until each pigs live weight approached 103 kilograms. The pigs were weighed and a P2 measurement recorded weekly. At approximately 103 kilograms live weight the pigs were slaughter and carcass weight and P2 measured. The results in table one show that there was a significant decrease of 14.8% in carcass P2 measurement due to the supplementation of betaine. After further examination it was found the variation between pigs in P2 backfat was decreased as can be seen from graph one. These changes can significantly increase the return to the pig producer.

Graph 1 Distribution of P2 backfat thickness with experimental herds



The understanding and biological mechanism of the lipotrophic effects of betaine are not understood and thus unclear as to how these responses could have occurred. The responses from many trials conducted around the world showed that the responses were not consistent and depended a lot on diet composition and the sex of the animal being trialed.

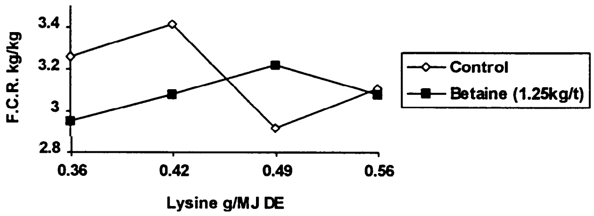
It was proposed that the effect on fat accretion may be mediated more via allocation of amino acids between lean growth, visceral growth and metabolic breakdown than by lipid metabolism per se (Virtanen and Campbell 1994).

The following experiments were designed to examine the interaction of betaine with lysine and methionine.

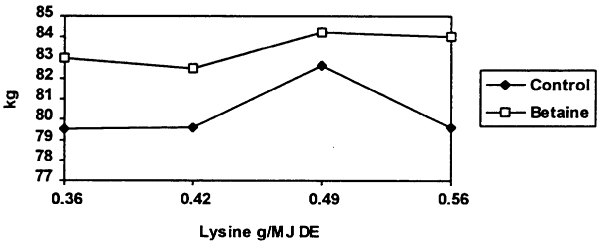
The first experiment involved eighty pigs in individual pens comprising equal numbers of males and females allocated at 70kg among eight treatments in a 2 x 4 factorial array. The respective factors were betaine at 0 and 1.25kg per tonne and dietary available lysine at 0.35, 0.42 0.49 and 0.56 g/MJ D.E. Growth performance and carcass data was collected on all animals.

The results of this trial showed that Betaine produced a significant interaction with lysine in gilts. The gilts fed the lowest level of lysine plus betaine having as a high a feed efficiency as the high lysine pigs. The backfat response in gilts was variable but trended towards being lower in gilts receiving betaine. The boars in this experiment responded differently to betaine in that there were trends in increased feed intake and growth but more importantly a trend towards increased carcass weight of approximately 3.2 kilograms at all levels of dietary lysine. There were no responses in backfat to added betaine.

Graph 2 Interaction of betaine and lysine on Feed efficiency in gilts



Graph 3 Interaction of betaine and lysine on carcass weight in males.



Similar reports of an increase in carcass weights have been reported in an unpublished trial from Spain where different energy levels were considered with betaine addition (Virtanen, pers comm).

The second experiment conducted at Bunge Meat Industries research facility was designed to study the growth and carcass responses of 65 to 100 kg live weight pigs to four levels of DL-methionine (0.19, 0.23, 0.27, 0.31%) supplemented with 0 or 1.25kg/t of betaine. All other amino acids set 30% above requirement. The results of the experiment are presented in table two.

Table 1 Effects of offering female pigs a diet supplemented with betaine from 60 to 103 kg on growth performance and carcass characteristics.

	Betaine (kg/tonne)		Significance	
	0	1.25	SEM	(P=)
Daily gain (g)	919	922	0.02	0.94
Feed:gain	3.06	3.01	0.02	0.58
Hot carcass weight (kg)	75.0	75.3	0.34	0.68
Dressing percentage (%)	72.8	73.4	0.29	0.32
Final P2 (mm)	17.6	15.0	0.49	0.03

Table 2 Interaction of betaine and methionine on finisher performance.

	Methionine (%)										
	0.19		0.23		0.27		0.31		P=		
Betaine (-/+)	-	+	-	+	-	+	-	+	B	M	BxM
Daily gain (g)	912	978	938	964	931	953	912	905	NS	NS	NS
Feed (kg/d)	2.60	2.61	2.39	2.57	2.52	2.63	2.96	2.51	NS	NS	NS
Feed:gain	2.90	2.70	2.71	2.76	2.69	2.84	2.72	2.80	NS	NS	.01
P2 (mm)	15.1	13.6	13.5	14.1	14.3	13.6	14.5	13.4	NS	NS	NS

The results show that the growth rate and feed:gain of pigs offered the diets without supplemental Betaine improved with increasing methionine up to 0.23%. Supplementation of the lower methionine diets with betaine had the same effect on feed:gain and a larger effect on growth as increasing the dietary methionine to 0.23%. This suggests that over the deficiency range tested methionine may be used for functions other than and possibly in preference to, protein synthesis and under these circumstances may be replaced by betaine.

Conclusion

Our knowledge about the mode of action of betaine on metabolism is increasing but more questions are raised from each piece of new information. The effect of betaine on fat deposition in the pig is dependant on the age of the pig, the length of time the animal is exposed to betaine, the sex of the animal and the genotype of the animal. In circumstance were the P2 backfat is causing significant reductions in income due to grading losses the use of betaine can reduce the variability seen in the backfat measurement. This response may not be the effect of betaine on fat metabolism but on protein metabolism.

The increase in carcass weight which has been described in the two experiments while not significant is believed to be a real result and further work is being considered to investigate this further.

In conclusion we have learnt that the biological reaction described in figure two plays a more important role in protein metabolism than previously thought by us. Betaine inclusion has significant benefits on protein metabolism that result in economical benefits to the producer in certain circumstances.

References

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