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Betaine improves energy utilisation

BETAFIN®

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As the consumer puts an increasing emphasis on meat quality and lean content the producer has to pay more attention to the way he grows his pigs. This article reviews a substance that among other things can decrease and/or redistribute carcase fat and considers its relevance to modern pig production.

Betaine has three chemically reactive methyl groups attached to the nitrogen atom of a glycine molecule. In its function as a methyl group donor betaine may partially replace choline and/or methionine in the diet.

This role of betaine has been extensively studied in broilers and this application is now widely used by the poultry industry.

Direct action

Due to its direct function in methylation reactions, betaine has a major influence on lipid metabolism: it is a lipotropic compound.

Betaine stimulates liver lipid mobilisation and reduces the amount of very low density lipoproteins.

Betaine also stimulates carnitine synthesis which is needed for the transport of fatty acids to the mitochondria where these are oxidised.

Studies with chicks and fish have indicated that betaine decreases and/or redistributes carcase fat in these species.

The second function of betaine is due to its bipolar structure which confers to this molecule osmoprotectant properties.

Betaine accumulates into cells and cell organelles, exposed to osmotic stress, replaces inorganic ions and protects macromolecules from ionic inactivation.

Osmotic stress results from disease, feed etc. Due to its osmoprotectant properties, betaine has been shown to have positive effects on nutrient utilisation, resulting in improved performance.

Australian studies

The results of the first two trials, conducted at the experimental station of Bunge Meat Industries in Australia, showed that Betafin supplementation (1-1.25kg/ton) during the finishing phase is an effective way to reduce P2 backfat in gilts (Table 1).

In addition, the gilts that received the diet supplemented with Betafin tended to exhibit a larger eye muscle area than their control counterparts.

Not only did betaine reduce the P2 backfat measurements but it also markedly reduced the variation in those values, resulting in a more homogeneous group.

As can be seen in Fig. 1, the extremely fat pigs were eliminated leading to the speculation that the effect of Betafin will be more marked in heterogeneous populations such as females and castrates rather than entire males.

Entire males, which can convert feed to lean tissue more efficiently, deposit less fat and therefore are less likely to receive a price discount at the slaughter plant due to excess backfat.

The effectiveness of betaine as a carcase modifier has been proven in numerous other trials, as well as under commercial conditions.

However, the results of some trials have indicated that when energy intake is increased, the response to betaine in terms of carcase quality (backfat or lean percentage) is lost.

In these trials increased energy intake was achieved either through increased energetic concentration of the diet (use of high level of fat), increased availability of the energy (use of enzymes) or increased feed consumption (comparison of ad libitum vs restricted feeding).

It should be noted that under commercial conditions competition between pigs and stresses (environment, disease) limit voluntary feed intake to below maximum capacity.

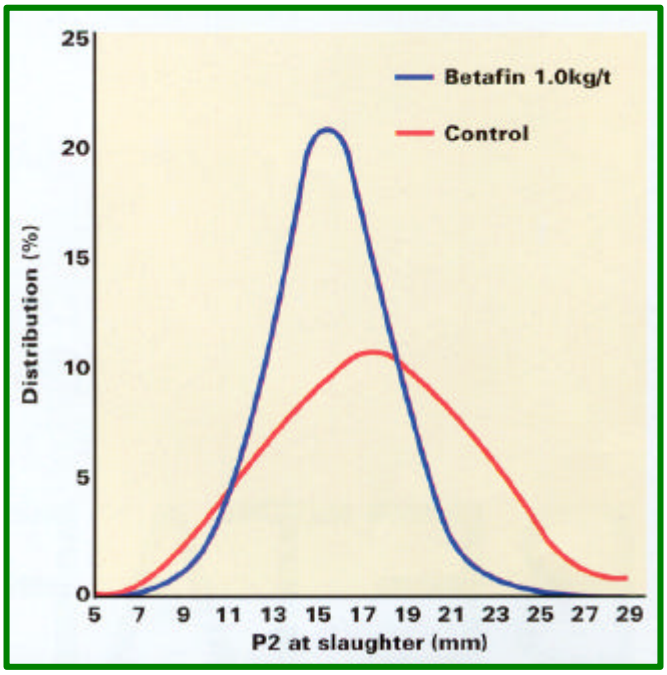
These results suggest that betaine's effect on carcase backfat may be exerted through an indirect pathway.

Betaine may just be simply improving the energy/nutrient availability of the diet, allowing thus an increased utilisation of the energy/nutrients by the muscle tissue and, as a result, diverting the nutrients away from lipid deposition in adipose tissue.

	Experiment 1		Experiment 2	
Parameter	**Control**	**Betafin**	**Control**	**Betafin**
Growth rate, (kg/day)	0.946	0.959	0.919	0.922
FCR	2.87	2.83	3.06	3.01
P2 backfat, (mm)	17.9	16.0	17.6	15.0
Eye muscle area, (cm^2)	ND	ND	36.8	38.8

Table 1. Effect of Betafin on growth performance and carcase characteristics of gilts.

Fig.1 Effect of Betafin on the individual variation of P2 backfat in gilts at slaughter.



Basic concepts

To understand the effect of betaine on growth performance and/or carcase characteristics, it is necessary to refer to basic concepts.

In pigs between 45-90kg liveweight, the relationship between energy intake and rate of protein deposition is of the linear/plateau form (Fig. 2).

As daily intake of energy increases, the daily rate of protein deposition increases until a point where there is no further increase in protein or lean tissue deposition.

The full potential of the pig for lean tissue growth has been reached.

The slope, breakpoint and maximal protein deposition level (plateau) is dependent on a series of factors, such as liveweight, sex, genotype, hormones and climatic conditions.

Campbell et al (1983) indicated that the same pattern applied for female pigs growing from 20 to 45kg liveweight, whereas for entire male pigs in that liveweight range protein deposition increased linearly with increasing energy intake to ad libitum.

Increased energy

Results from the latest trials carried out in research institutes suggest that the effect of betaine is to increase the energy/nutrient value of the diet.

Thus, the response to betaine supplementation in terms of carcase parameters (backfat thickness and lean percent) will depend on whether the pigs are below or have reached their genetic capacity for protein accretion (Fig. 3).

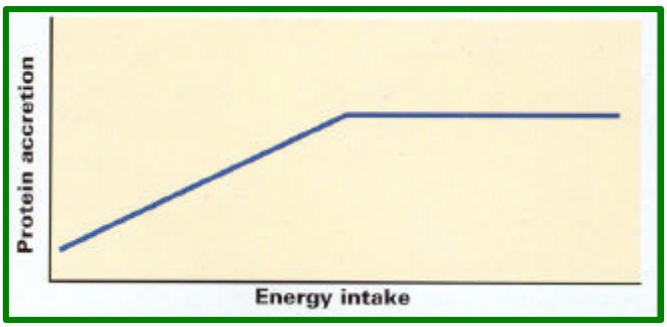


Fig. 2 Relationship between energy intake and rate of protein deposition.

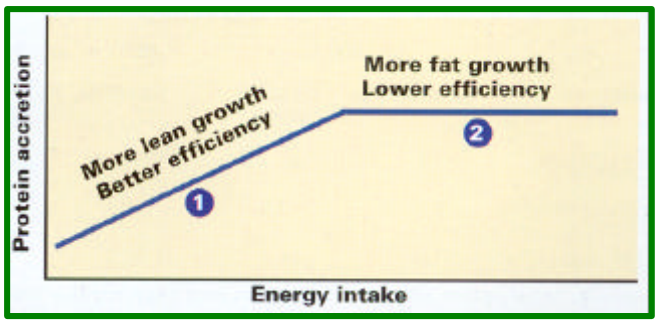


Fig.3 Effect of energy intake on responses to betaine in pigs. 1 = Supports betaine's effect on carcase and efficiency and 2 = Counteracts betaine's effect on carcase.

Pigs that are still in the linear portion will respond to an increased energy value of the diet with an increased protein deposition.

The net result is a bigger loin eye area and less backfat.

Conversely, pigs that have reached their genetic ceiling will not respond to an increased availability of energy/nutrients with increased protein deposition.

Therefore, the extra energy available will be used to deposit more fat (hence a thicker backfat).

Supporting data

Data from two trials completed recently support the concept that betaine supplementation increases the energy/nutrient value of the diet.

The objective of the first experiment, run at the Instituto Internacional de Investigación Animal in Queretaro, Mexico, was to look at the effect of Betafin (1kg/ton) on the performance of growing gilts and castrated males fed either on a restricted or an ad libitum basis.

During the growing phase (days 70-126), castrated male and female pigs receiving diets supplemented with Betafin exhibited better feed conversions than their control counterparts, the magnitude of the improvement being greater for the pigs fed on a restricted basis (Table 2).

As expected, gilts fed on an ad libitum basis consumed less feed than the barrows did and their response to Betafin was greater.

These results indicate that it is beneficial to supplement Betafin during the growing period.

During the finishing phase (days 126-150) the trends were similar for the growing period but the differences between control and betaine fed groups were not significant, the exception being for gilts fed on a restricted basis.

Overall, feed conversion was improved by betaine supplementation in both castrated males and females fed on a restricted basis.

Pigs fed betaine had less backfat at all levels of intake: 23% improvement for pigs fed ad libitum and 28% for the restricted fed pigs (Table 3).

The effect of betaine supplementation on percent lean was more pronounced in gilts.

The results of this experiment suggest that Betafin supplementation would be most effective in improving performance under conditions where feed intake is below the pig's potential.

The second trial, which was run at Louisiana State University, studied the interactive effects of Betafin, energy level and protein level but the focus here will be on the interrelationships between Betafin (0 or 1.25kg/t) and energy level (0 or 6% added fat).

Hence only the treatment groups receiving diets adequate in crude protein (and amino acids) will be taken into consideration.

The roots of success!

Table 2. Interactive effects of Betafin and feed intake level on growth performance of growing-finishing pigs.

	BARROWS				GILTS			
	Ad libitum		80% of ad libitum		Ad libitum		80% of ad libitum	
Criterion	Control	Betafin (1kg/t)	Control	Betafin (1kg/t)	Control	Betafin (1kg/t)	Control	Betafin (1kg/t)
Growing								
ADG (kg/d)	0.886	0.888	0.751	0.759	0.805	0.798	0.691	0.762
ADFI (kg/d)	2.138	2.113	1.598	1.552	1.995	1.854	1.532	1.559
Feed:gain	2.413	2.379	2.127	2.044	2.478	2.323	2.217	2.045
Finishing								
ADG (kg/d)	1.038	1.023	0.904	0.936	0.888	0.813	0.797	0.917
ADFI(kg/d)	2.960	2.898	2.162	2.156	2.673	2.368	2.082	2.140
Feed:gain	2.851	2.832	2.391	2.303	3.006	2.912	2.612	2.330
Overall								
ADG (kg/d)	0.932	0.929	0.798	0.813	0.830	0.803	0.724	0.809
ADFI (kg/d)	2.385	2.349	1.767	1.733	2.198	2.008	1.678	1.733
Feed:gain	2.559	2.528	2.214	2.131	2.648	2.500	2.317	2.142

	BARROWS				GILTS			
	Ad libitum		80% of ad libitum		Ad libitum		80% of ad libitum	
Criterion	Control	Betafin (1kg/t)	Control	Betafin (1kg/t)	Control	Betafin (1kg/t)	Control	Betafin (1kg/t)
Dressing (%)	83.4	82.7	80.7	80.1	83.0	82.7	80.7	80.2
Backfat (mm)	14.2	11.2	12.0	10.5	13.0	9.7	13.0	7.5
Lean meat (%)	51.0	50.6	52.2	52.3	51.7	54.4	53.0	55.1

Table 3. Interactive effects of Betafin and feed intake level on carcase parameters of growing-finishing pigs.

Conversion calculated

To be able to compare the results obtained with diets differing in their energy density, the efficiency of energy conversion (kg growth/Mcal ME intake) was calculated for all treatments (Fig. 4).

Overall, the gilts receiving the diet supplemented with Betafin were 8.2% more efficient than their control counterparts.

For pigs receiving the diets containing high levels of fat, the magnitude of the improvement caused by Betafin supplementation was only 2.3% over their control counterparts.

It is also relevant to compare the effect of the addition of either Betafin or fat: the gilts receiving the diet supplemented with Betafin were 15% more efficient than the gilts eating the high fat diet.

Alternative uses

These data again support the idea that Betafin supplementation is more beneficial at lower levels of energy intake but also suggest that Betafin supplementation may be used as an alternative to high fat addition.

Betaine seems to improve energy/nutrient availability, the magnitude of this response being about 5-8%.

How does betaine produce this effect?

Results from an experiment carried out at Bunge Meat Industries in Australia indicate that the effect of betaine is mediated through a reduction in the maintenance requirement of the pigs.

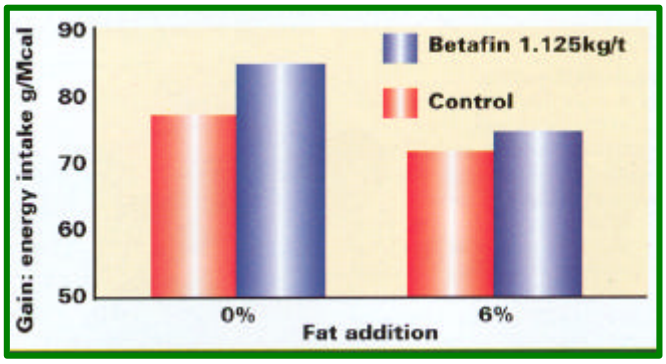
Further research is currently being undertaken to determine on what component of the maintenance requirement betaine is acting upon.

The highest benefit of using Betafin in swine operations is with the 'energy boosting' effect of betaine.

In the case of growing and finishing pigs with submaximal energy intake, as is frequently the case under commercial conditions, Betafin used as a feed supplement will result in improvements in feed efficiency in the range of 5-8%.

If energy intake is sufficient to support maximal lean growth, such as is the case when high fat levels (4-7%) are included in the diet, the utilisation of Betafin results in cost savings by allowing for the removal of part of that fat without affecting the performance of the pigs. To achieve the best performance, Betafin should be used during both the grower and finisher periods. The recommended inclusion level of Betafin is 1kg/ton. □

Fig. 4. Effect of Betafin and energy on the efficiency of energy conversion of finishing gilts.



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