The role of vitamins in pork products

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Traditionally pork has held a special place in the human diet because of its appealing taste and its high nutritional value. Pork is a good source of protein, B vitamins, such as thiamin, niacin, vitamin B6, riboflavin and vitamin B12, and minerals like phosphorus, zinc, iron and selenium.

Over the last decades, through genetic selection and changes in feeding strategies, pork producers have responded to consumer demands for leaner pork.

Comparing data from the US Department of Agriculture for 2006 and for 1991, it is evident that six of the most common cuts of pork are now significantly leaner and much lower in saturated fat than they were 15 years ago (Table 1).

In fact many of today's favourite pork options are among the leanest meats in the USDA database (see www.ars.usda.gov/nutrientdata).

Pork is the most widely eaten meat in the world (Table 2), providing about 38% of daily meat protein intake worldwide, although consumption varies from country to country. This is despite religious restrictions on the consumption of pork by about a third of the world's population.

The meaning of quality

For pork to be considered the meat of choice, along with price, quality is the major issue impacting its image. However, there are many definitions of quality in the pork business.

Quality can encompass a combination of factors including taste, appearance, colour, leanness, ultimate pH, water holding capacity, intramuscular fat, nutritional value, wholesomeness and safety.

Every segment of the pork market chain (producer – processor/packer – retailer – consumer) has quality expectations and contributes to the quality of the product.

Currently most producers are paid a premium for high lean, low fat, heavy carcases but carcase merits beyond these traits are rarely considered in producer payments.

However, the increasing development of branded, value added and further processed meat products and greater vertical integration through the marketing chain has placed further emphasis on retailer and consumer demands for pork quality.

Achieving the goal

Pigs must consume optimal amounts of all nutrients to meet their requirements for maximum performance and to produce a carcase of the desired quality.

Optimising vitamin nutrition is one important aspect in achieving this goal. It is well accepted that vitamin deficiencies affect productivity, health and welfare, as well as meat quality, in swine production and can be prevented by appropriate dietary supplementation. For this reason, recommendations from governmental agencies have been developed in many countries.

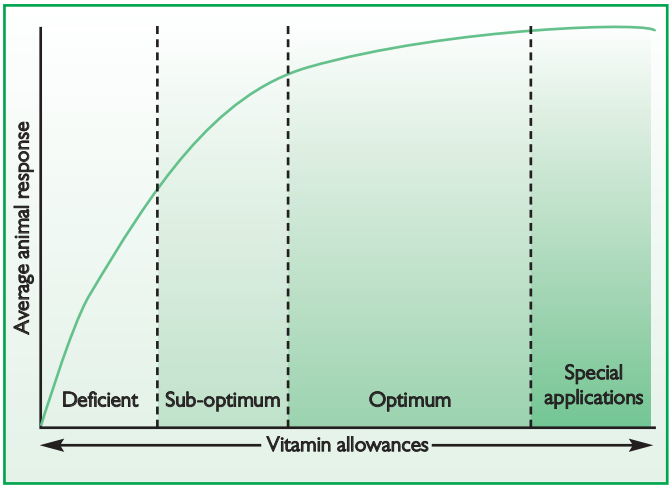


Fig. 1. Optimum vitamin nutrition concept (DSM).

However, the main focus of these recommendations is to avoid clinical deficiencies. In order to achieve the maximum financial return from pig production, vitamin supplementation guidelines should be regularly updated as the genetic potential for growth is improved.

As with all dietary nutrient inputs, such a review is essential to ensure that the full potential of the genotype is realised in terms of maximum productivity and product quality, and also to protect the health and well being of the animals.

The OVN concept

To cover these needs the Optimum Vitamin Nutrition (OVN) concept has been established by DSM. The OVN concept takes into consideration recent advances in nutrition research, modern genetics and different production systems.

It gives a defined range of vitamin supplementation levels that can be adapted for each farm according to specific needs.

The OVN concept gives nutritionists the opportunity to select vitamin supplementation levels that will give the maximum return in a cost effective manner.

Over the last few years new research findings provided further support to justify this concept (Fig. 1).

Improving pork products

Traditionally, pig producers measure the performance of the growing animal in terms of daily weight gain and feed conversion.

However with increasing emphasis on carcase leanness, the rate of lean tissue deposition has become a more important measure of perfor-

Continued on page 13

Table 1. Pork nutrient data: 1991 vs 2006 per 90g cooked serving (USDA nutrient data set for fresh pork).

	1991 Fat (g)	2006 Fat (g)	1991 Saturated fat (g)	2006 Saturated fat (g)
Pork tenderloin	4.09	2.98	1.41	1.02
Pork boneless top loin chop	6.60	5.17	2.72	1.77
Pork top loin roast (boneless)	6.13	5.34	3.08	1.64
Pork centre loin chop	6.86	6.20	2.51	1.83
Pork centre rib chop	8.28	7.10	2.94	2.17
Pork sirloin roast (bone-in)	8.75	8.02	3.08	2.44

Table 2. World meat production (USDA official statistics 2006 and 2007 estimate).

	2006 million tons carcase weight equivalent	2007 est. million tons carcase weight equivalent
Beef and veal	53.5	54.7
Pork	99.8	103.4
Poultrymeat	65.0	66.0
Total	218.3	224.1

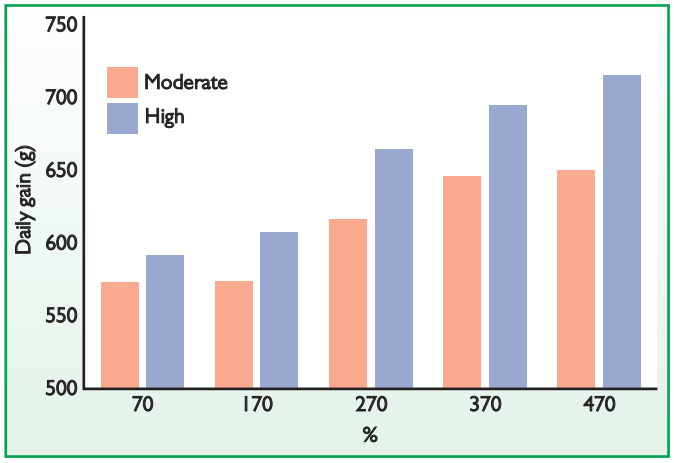


Fig. 2. Pig response to dietary B vitamin concentrations in a high and a moderate lean strain (Stahly et al. (2007), J. Anim. Sci. 85: 188-195).

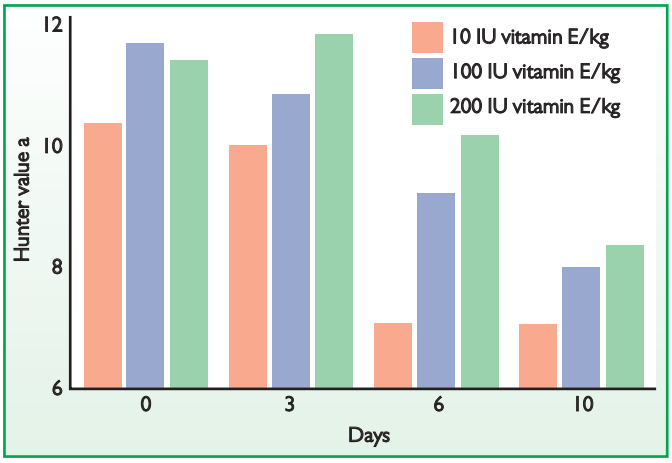


Fig. 3. Effect of supra-nutritional dietary vitamin E on colour of meat (Asghar et al. (1991), J. Sci. Food Agric. 57: 31-41).

Continued from page 11

mance and of genetic merit. Faster growing pigs of modern genetic strains have a greater capacity for lean tissue accretion and thus greater vitamin needs.

In particular, the B vitamins are key elements in lean tissue growth because of their role in energy and protein metabolism. It is also important to recognise that selection for improved feed conversion has reduced feed intakes, which means that the concentration of vitamins must be increased to meet the daily needs. Lindemann (1999) conducted a study with five B vitamins (niacin, pantothenic acid, riboflavin, B12 and folic acid) fed at 70, 170, 270, 470 and 870% of the NRC (1998) requirement to grow-finish pigs up to 100kg body weight.

	Dietary B vitamin (% NCR) (1998)				
	70	170	270	470	870
Daily gain (g)	870	904	940	930	914
Feed/gain	2.87	2.88	2.79	2.88	2.90
Loin depth (mm)	52.9	57.4	58.8	57.8	58.2
Lean (%)	52.9	53.2	53.6	53.7	53.3

Table 3. Responses of grow-finish pigs from 50-100kg growth stage to dietary B vitamin regimen (Lindemann et al. (1999), J. Anim. Sci. 77 (suppl. 1) :58).

Daily weight gains and body composition were maximised by dietary B vitamin concentrations equivalent to 270% (Table 3).

Similar studies were conducted by Stahly et al. (2007) where a high lean genotype pig was compared with a moderate strain pig.

In these studies Stahly and his colleagues demonstrated that pigs with high capacities for lean tissue growth required as much as four times the daily B vitamin needs currently defined by NRC (Fig. 2).

One of the main criteria for consumer acceptance of pork products is its appearance. There is a dietary approach to maintaining a darker, red colour for fresh pork products during retail storage.

Numerous studies have confirmed that substantial increases in the muscle/meat content of the anti-oxidant vitamin E can be readily achieved by increasing the vitamin E content in pig diets. High levels of supplementation of pig diets with vitamin E (200ppm) resulted in improved colour stability after several days of refrigerated storage (Fig. 3).

Additionally, drip loss during refrigerated storage and during thawing after frozen storage was also reduced in meat from supplemented animals.

Supra-nutritional levels of vitamin E in the diet of pigs have also been evaluated for their potential to prevent the oxidation of unsaturated fatty acids. The current desire to enhance the omega 3-fatty acid content of pork by increasing the content of these fatty acids in the pig feed can lead to a problem with rancidity. The improvement of the organoleptic qualities of the meat by feeding high levels (300mg/kg) of vitamin E to pigs 61 days pre-slaughter was demonstrated by Niculita et al (2007). The concentration of vitamin E in blood and muscles increased and blood cholesterol level decreased with 100 and 300ppm vitamin E in the diet compared to the control with 11ppm vitamin E in the feed.

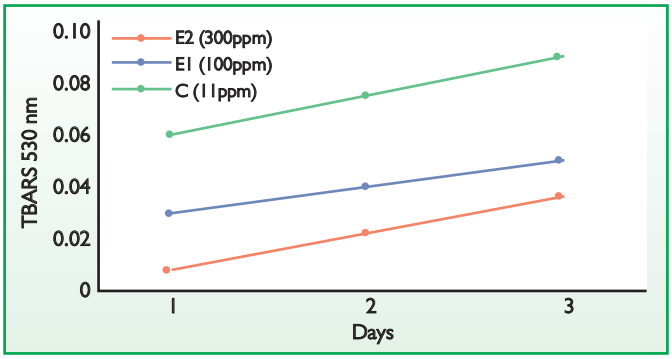
The oxidative stability of lipids in the Longissimus dorsi during storage was improved by dietary vitamin E supplementation.

Thus the development of thiobarbituric acid reactive substances (TBARS) was reduced in the muscle of the treatment groups versus control. The reduced production of TBARS was also seen in stored and refrigerated meat (Fig. 4).

Clearly, supra-nutritional supplementation with vitamin E can be very beneficial, especially with the current emphasis on modification of the fatty acid composition of animal tissues in order to produce functional foods.

Another vitamin with antioxidant properties is vitamin C which may act synergistically with vitamin E. Positive effects on colour improvement were reported by Peeters et al. (2007) as a result of supplementing feed with 300mg/kg of vitamin C. Also Kremer et al. (1999) reported an improvement in water holding capacity and colour as a result of vitamin C supplementation at four hours pre-slaughter. Other trials with short term feeding of vitamin C showed similar effects on pork quality. However, some other studies did not confirm these findings. The level of stress and genotype of the animal could explain this apparent inconsistency in scientific findings.

Fig. 4. Lipid oxidation in Longissimus dorsi of pigs fed diets with different levels of vitamin E (Niculita et al. (2007), Pol. J. Food Nutr. Sci., 57:125-130).



Conclusion

Pig meat has traditionally held a special place in the human diet for many communities around the world, because of its appealing flavour and texture and its high nutritional value.

In the past the approach to pig nutrition mainly focused on the performance parameters of the animals such as live weight gain and feed conversion.

Today, certain aspects of end product quality are coming under increasing consideration. As value added and functional foods receive more focus, some producers already see the opportunity for branded products and for product differentiation by incorporating certain feed additives into the feed for swine.

As with all nutrients, vitamin requirements should be monitored carefully to serve the needs of today's pig. Evidence suggests strongly that vitamin allowances must be increased in order to exploit the full potential of modern genotypes. The studies with increasing levels of B group vitamins demonstrated this very clearly.

Furthermore, one of the main factors limiting the quality and acceptability of meat and meat products is lipid oxidation. This process leads to discolouration, drip losses, off odour and off flavour development.

Antioxidant substances like vitamin E and vitamin C are effective in reducing these quality problems.

The Optimum Vitamin Nutrition concept is key to help producers to get the maximum benefit of raising pigs and also the consumer to enjoy pork products of high nutritive value and quality. ■