Improving Meat Quality through Nutrition

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▪ Introduction

Are you a pig producer or a pork producer? Is there a difference? You bet there is! Savvy producers recognize their livelihood depends to a large extent on satisfying packer demands for quality carcasses. The packer in turn responds to retailer demands for quality meat and the retailer responds to consumer demands for healthy, nutritious, flavourful and convenient food.

Currently, producers are paid premiums for high lean, low fat, heavy carcasses but carcass merits beyond these are not factored into producer settlements. However, increased emphasis on value-added/branded-product meats and greater vertical integration through the marketing chain has placed further emphasis on retailer and consumer demands for pork quality. These demands will in all likelihood translate into packer paid premiums for quality or value-added traits and producer prosperity will depend on their abilities to respond to market demands.

As the old saying goes “you are what you eat”, therefore, producers might first look toward customizing diets with specialty nutrients as a means to enhance pork quality. Three of the most promising feed additives to enhance pork composition and quality that we have worked with at the Lacombe Research Centre are ractopamine, conjugated linoleic acid, and Vitamin E.

▪ Ractopamine

Ractopamine hydrochloride (Paylean®) was recently registered for use in finishing pigs in the United States, but has not yet been approved for use in Canada. Ractopamine is a β-1 agonist that binds to receptors on muscle and adipocyte membranes and exerts its action through activation of one of the major intracellular signaling molecules (Mersmann 1998). This molecule, cyclic

adenosine monophophate (cAMP), acts on many aspects of cellular metabolism, increasing fat degradation and protein synthesis, and decreasing protein degradation.

As a result, when added to the feed during the finishing phase, ractopamine has been found to improve average daily gain (+0-10%), improve feed conversion efficiency (+5-15%), decrease carcass fatness (-10-15%) (Anderson 2000) and increase carcass lean (+2-5%) (Aalhus et al. 1990; Dunshea et al. 1993; Xiao et al. 1999). In our work at Lacombe (Aalhus et al. 1990, 1992), the greatest increases in lean were found in the ham (10.7%). In addition, there was a clear anterior to posterior gradient for fat reduction in both the subcutaneous (Picnic 13.4%, Butt 13.5%, Loin 10.7%, Ham 8.2%) and intermuscular (Picnic 16.2%, Butt 13.7%, Loin 8.8%, Ham 5.3%) fat depots.

In order to maximize the effects of ractopamine, Dikeman (2000) pointed out the necessity of increasing the nutrient density of the ration since increased lean deposition occurs without a corresponding increase in feed consumption. Studies have shown ractopamine treated pigs respond favourably to increased dietary protein (Xiao et al. 1999) and levels of other nutrients may need to be increased as well.

Ractopamine has been reported to have variable effects on meat quality and Merkel (1988) and Dikeman (2000) have summarized these effects. In general, ractopamine has only minor effects on most meat quality characteristics, although an increase in shear force (decrease in tenderness) has been reported in some studies (Aalhus et al. 1992; Uttaro et al. 1993).

▪ Conjugated Linoleic Acid

Fats and oils have traditionally been used as high-energy feedstuffs for pigs to maintain feed intake in warm climates and to reduce dust levels. Feeding fat also improves feed to gain and may thus prove useful in reducing manure output. Early fat research focused on determining digestibilities of fats from different sources and found most differences were due to differences in levels of saturated and unsaturated fatty acids. More recently, the correlation between saturated fat (14:0 and 16:0) intake and coronary heart disease in humans has promoted interest in changing the fatty acid composition of pork. ‘Healthier’ branded pork products could potentially increase pork’s market share and may provide a means for ‘value-added’ marketing. However, the benefits of feeding high levels of unsaturated fats have been counterbalanced by problems with carcass fat softness, oxidative instability of meat and at a practical level, feeders can get blocked when dietary fat/oil levels are too high.

Studies of feeding fats and oils to pigs have typically focused on easily measured parameters including feed intake, feed conversion and the incorporation of dietary fatty acids into body tissues. A topic that has received relatively little attention is how fatty acids differ in their metabolism and what effects these might have on carcass composition and pork quality. One fatty acid, conjugated linoleic acid (CLA), has recently been demonstrated to have physiological activities over and above being just an energy source. CLA is a byproduct of rumen biohydrogenation of unsaturated fats in cattle and, once absorbed, can be incorporated into meat and milk. Most beef and dairy products are good sources of CLA (approximately 0.5-1.5% of total fatty acids) while meats from pigs and poultry contain relatively little CLA (0.1-0.2% of total fatty acids) (Fogerty et al. 1988; Chin et al. 1992).

In the past, the content of CLA in meat and dairy products was considered of little importance, but much interest has developed due to reports that CLA consumption may actually be healthy. In laboratory animals, CLA has been shown to protect against atherosclerosis (Nicolosi et al. 1997; Lee et al. 1994) and many types of cancer (Belury 1995; Ip 1997). In addition, CLA has been reported to improve feed efficiency in rats (Chin et al. 1994) and repartition body fat to lean in mice (Park et al. 1997). Our interest was, therefore, piqued to determine if CLA could repartition fat to lean in pigs and provide CLA enriched pork for human consumption.

We have now completed two CLA feeding trials measuring feed intake, growth rate, carcass composition, pork quality and palatability (Dugan et al. 1997, 1999). CLA did not affect growth rate and feed intake/conversion results were mixed. Overall CLA reduced subcutaneous fat (6.6-6.8%) and increased lean (2.3-2.7%) in commercial pork cuts. Surprisingly, CLA's fat to lean repartitioning effects were diminished when fed with higher levels of canola oil, but results indicate this might be due to canola oil having fat to lean repartitioning effects of its own. Interestingly, although CLA reduced subcutaneous fat, it consistently increased levels of loin muscle intramuscular fat (2.3-3.8 g/kg fresh weight) and intramuscular or 'marbling' fat contributes positively to meat palatability. In addition, although feeding canola oil softened subcutaneous fat, feeding CLA actually increased fat hardness and thus may also be useful in designing pork where fat softness has previously been an obstacle. Currently there are two sources of CLA; one is synthetic and produced by alkaline isomerization of linoleic acid enriched vegetable oils. A second novel source is modified tall oil, which is a byproduct of the paper industry (O'Quinn et al. 2000).

▪ Vitamin E

Membrane lipid oxidation of phospholipids is a major cause of deterioration in the quality of muscle foods and can affect many quality characteristics such as flavour, colour, texture, nutritive value and safety of the food (Buckley et al. 1995). Vitamin E (α-tocopherol) is a major, lipid-soluble antioxidant, and one of its primary functions is to maintain and protect biological membranes against lipid peroxidation. As such, inclusion of Vitamin E above dietary requirements can be effective in reducing quality defects associated with lipid peroxidation.

In pigs, Vitamin E is generally supplemented at the 200 mg/kg of feed level (Monahan et al. 1990; Asghar et al. 1991). No negative effects of feeding these levels have been documented for feed intake, growth rate, feed efficiency, dressing percent, or meat yield percentage (Dikeman 2000). However, these levels of supplementation did result in improved colour stability after 3 and 6 d of refrigerated storage (Asghar et al. 1991). Drip loss during refrigerated storage and during thawing after frozen storage was also reduced in meat from supplemented animals (Asghar et al. 1991). Beneficial effects on sensory data (freshness, tenderness and juiciness) and on the oxidative stability of pork has also been reported (Dirinck et al. 1996). 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. The entire production, processing, and retail segments of the industry may gain from swine producers feeding supra-nutritional levels of Vitamin E.

▪ Conclusion

The emphasis in agriculture today is on value-added, functional foods. Vertical integration and the ability to market branded products means producers can benefit from incorporating specialty nutrients such as ractopamine, CLA and Vitamin E into their swine rations. These, and more opportunities to produce pork, rather than pigs, will be available to the savvy producer in the 21st century.

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