A PRACTICAL LOOK AT NUTRITIONAL ATTEMPTS TO IMPROVE PORK QUALITY

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ABSTRACT

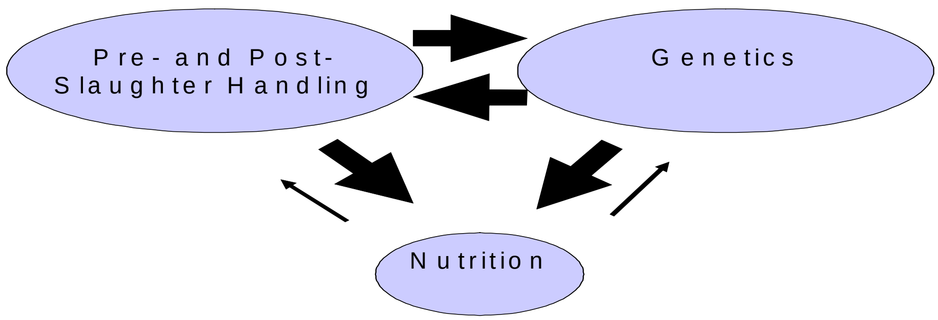
When one reviews the literature examining the effects of diet on pork color, water-holding capacity, and other quality indicators, results are highly variable. It is not uncommon to find one or two studies where manipulating the diet improved some aspect of pork quality, and find at least as many studies where the same experimental factors yielded no change at all. Factors such as genetics and pig handling before and after slaughter will be much more important in influencing pork quality than nutrition.

INTRODUCTION

Nutrition is frequently considered an important factor affecting pork quality; however, it is essential to realize that it plays a relatively minor role compared to genetics and pre- and post slaughter handling. Furthermore, genetics and especially pig handling around the time of slaughter could also be considered as dominant factors compared with nutrition (Figure 1). For example, pigs fed properly and with the genetic potential for excellent pork quality traits, can still exhibit a higher than average incidence of poor pork quality if they are improperly handled around the time of slaughter. In this example, good nutrition and genetics might be able to mitigate a very minor portion of the detrimental effects of poor handling, but they are certainly not going to be able to totally overcome the effects of poor handling. Likewise, excellent handling around the time of slaughter and good nutrition may only offset a minor percentage of the problems associated with genetic predisposition for poor pork quality (i.e. Halothane and Napole genes). Providing pigs a magical concoction of nutrients prior to slaughter will not be enough to over-ride the potentially negative effects of genetics or pig handling around the time of slaughter.

Because pre- and post-slaughter handling and genetics play such a dominant and over-riding role compared with nutrition on pork quality, this is probably the reason why nutrition/pork quality research is so variable. Specific combinations of factors involved with an individual experiment may create a situation where a dietary nutrient may elicit an improvement in pork quality. However, when replicated in a second experiment, handling around the time of slaughter or genetics may not be identical, and thus the particular response is not duplicated.

Figure 1. **Relative importance of pre- and post-slaughter handling, genetics, and nutrition on pork quality. Arrows indicate the relative degree that one characteristic can dominant any potential contribution of a different characteristic.**



Therefore, as the swine industry moves towards producing a product with improved color, firmness, and water holding capacity, this will necessitate that genetic suppliers, production systems, and pork processors work together to standardize as many of their practices as possible. Then, once stability has been achieved from beginning to end, this will provide the framework in which to fine-tune and evaluate nutritional manipulation of pork quality. Because of the increase in development of case-ready, and(or) branded products, and the ever increasing export of pork from North, Central, and South America to the rest of the world, enhanced pork quality by adjusting components of the entire production process, not just nutrition, will become critical for pork production systems to succeed.

DEFINITIONS OF PORK QUALITY

An issue not previously mentioned in the discussion of pork quality that can also represent a potential source of variation is its actual definition. Pork quality can have many different meanings to different people within the pork production chain (Table 1; adapted from Coma, 2001). Furthermore, these individual aspects of pork quality may require very different solutions to achieve them. Areas such as food safety and social implications of pork production will prove to be formidable challenges in the future considering changes in global population and economic status.

Carcass Characteristics

One area frequently associated with pork quality is carcass leanness. Obviously, under- and to a lesser extent over-feeding lysine will affect carcass lean to fat ratio. It has been thought by some that perhaps purposely under-feeding lysine in the late finishing stage of growth may increase intramuscular fat (marbling) and therefore produce cuts of pork with greater tenderness and juiciness. However, this strategy has serious production implications. Recent research suggests that unlike the growing pig (25 to 75 kg), slightly underfeeding lysine in late finishing (75 kg and above) has by far a greater negative impact on gain and feed conversion (Main et al., 2002). In that study, feeding 10% and 20% below the pig's estimated requirement for only a 4-week period added $0.72 and $2.48 in added feed cost, respectively. This does not take into account the negative effects of increasing the number of days needed in finishing space or the revenue lost by selling lighter pigs. Furthermore, it would appear to take approximately 5 weeks of feeding a low lysine diet to achieve increased longissimus marbling (Cisneros et al., 1996), and improvements in marbling appear to be offset by poorer water holding capacity and tenderness (Goodwin 1995). The economic incentive to produce pork carcasses with above average marbling would need to be extremely large to offset the added production costs in the majority of commercial production systems.

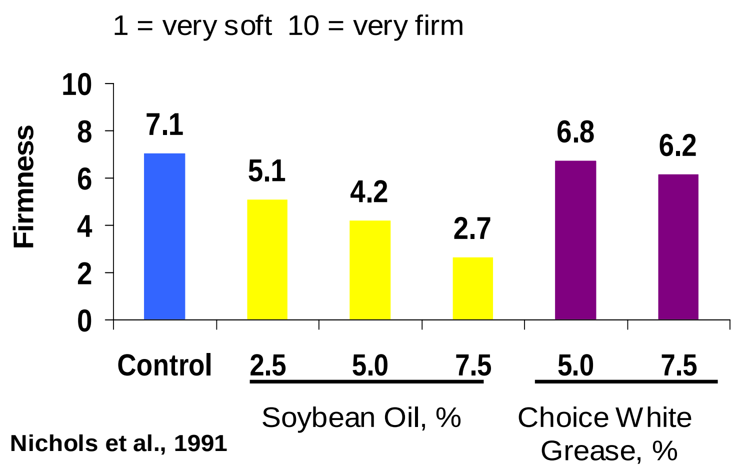
Table 1. Various aspects of pork quality (adapted from Coma, 2001).

Item	Attribute
Food Safety	Microbiological hygiene: absence of Salmonella, Campylobacter. Absence of residues: Antibiotics, growth promotents, metals, pesticides, etc.
Eating Quality	Tenderness, juiciness, flavor, and smell Quantity of visual fat, degree of marbling. Cooking losses.
Nutritional Value	Quantity of fat and composition of fatty acids. Protein content. Vitamins and Minerals. Enrichments.
Technological Quality	Carcass and fat firmness, pH, water holding capacity, tissue separation, oxidative stability (shelf-life).
Social Quality	Animal welfare, environmentally responsible, business structure (large vs. small farms).

Fat Characteristics

Another aspect of carcass characteristics relating to pork quality is not only the amount of but also the chemical characteristics of the adipose tissue. It is well known that pigs deposit fat very similar to the composition of dietary fat consumed. Therefore pigs fed a diet high in unsaturated fatty acids typically exhibit carcasses with what is referred to as "soft pork". Soft pork results in a number of problems including: difficult fabrication and in particular slicing of bellies for bacon, increased separation of fat layers and muscle, fat smearing in processed pork, and pork cuts that are less firm and undesirable to the consumer. The effects of feeding finishing pigs (55 to 110 kg) increasing choice white grease or soybean oil on carcass firmness is presented in Figure 2 (Nichols et al., 1991). In that study, increasing soybean oil decreased carcass firmness, but increasing choice white grease had relatively little effect. Woodworth et al. (1999) observed that finishing pigs fed 6% poultry fat had bellies that were significantly less firm than pigs fed no added fat, whereas pigs fed 6% choice white grease had intermediate belly firmness. Engle et al. (2001) observed similar trends in pigs fed choice white grease and poultry fat; however, in that study, feeding only 4% of either fat source did not appear to as negatively affect belly firmness as feeding 6% fat.

Figure 2. Effect of fat source on carcass firmness.



Danish Meat Research Institute standards for fat firmness recommend an Iodine Value (IV, measure of the degree of unsaturated fatty acids with the higher the value the higher the degree of unsaturated fatty acids) of pork to be no more that 70. Boyd et al. (1997) suggested that many pigs fed corn-based diets would exceed this standard, and recommended an IV of 74 with a dietary maximum of 2.1% linoleic acid (C18:2).

For these reasons, feeding unsaturated fat sources such as soybean oil and poultry fat should be minimized or in the very least the duration of feeding monitored. Data from Wiseman et al. (1993) suggests that it takes approximately 25 to 30 days to observe a shift in fatty acid profile. However, more research is needed evaluating the effects of different feeding durations and sequencing strategies with predominately unsaturated vs. saturated fat sources.

A nutritional supplement that has a consistent and dramatic effect of fat firmness is conjugated linoleic acid (CLA) or modified tall oil (also a source of conjugated C:18 2 isomers). Either of these compounds improves carcass firmness by increasing the percentage of saturated fatty acids deposited compared with unsaturated fatty acids (O'Quinn et al., 2000a). Should either of these compounds be fully cleared for use in swine feed and if the appropriate economic incentive was in place, it is likely that they would be used because there is little question regarding their efficacy in improving belly firmness.

Because the pig will deposit fat similar to its dietary composition, the possibility of producing pork products with specific "nutraceutical" characteristics such as greater than average concentrations of a specific fatty acid or fat soluble compounds is not outside the realm of possibility. However, it is probable that such marketing strategies would rely heavily on smaller scale niche markets.

Within the past two years the issue of fat color has gained in research interest. This has to deal with the potential, that carotenoids and other fat-soluble pigments, primarily in yellow dent corn, negatively affect fat color. Recent studies would suggest no differences in pork longissimus or fat color scores between pigs fed yellow and white corn (Fent et al., 2003), or yellow or white corn, and barley (Lampe et al., 2003a,b,c). Based on these recent studies it would appear that primary grain source has little overall impact on pork or fat color.

NUTRITION FACTORS INFLUENCING PORK QUALITY

Feed Withdrawal

The practice of withdrawing feed from pigs 12 to 18 hours before slaughter should result in emptying of the stomach and gastrointestinal contents. This will result in less potential carcass contamination from accidental cuts to the gastrointestinal tract during evisceration, a food safety concern. In addition, feed withdrawal may decrease the glycogen reserve of muscles at slaughter. Less glycogen would result in less conversion to lactic acid and therefore a high ultimate pH. Binder et al. (1998: as cited by Ellis and McKeith, 1999) observed that meat color and pH was improved for pigs held off feed if they were homologous recessive for the Napole gene. In pigs that carried the dominant allele, feed withdrawal had no effect. However in a second study there was no benefit at all to feed withdrawal. The authors indicated that in the first study, pigs were regrouped and mixed at the time of feed withdrawal, whereas in the second study they were not. Therefore, they speculated that the stress and possible glycogen depletion from fighting during the mixing period was also a variable that had to be considered.

Other factors to consider with feed withdrawal are how to effectively remove the pig's access to feed as well as knowing when the majority of pigs have last eaten. Fasting for greater than 24 hours will result in tissue loss. These factors combined with potential transportation delays as well as variable lairage times at the packing plant make feed withdrawal as a means to improve pork color a difficult challenge.

Vitamin E

Without question the most widely studied nutrient on affecting pork quality is vitamin E. Vitamin E is speculated to enhance pork quality by two possible mechanisms (Pettigrew and Esnaola 2000). The first is that antioxidants such as vitamin E inhibit the conversion of oxymyoglobin (red color) to metmyoglobin (brown color). This would result in maintaining acceptable pork color for longer durations of storage. The second proposed hypothesis is that antioxidants like vitamin E help maintain cell membrane stability, which reduces drip loss and oxidative rancidity. Feeding high levels of vitamin E has been observed to produce pork with a darker color and the ability to maintain color stability longer than non-supplemented controls. Vitamin E supplementation has also been shown to reduce drip loss and lipid oxidation. However, it is important to point out that these beneficial effects on pork quality do not become apparent until tissues have become "saturated" with vitamin E. Asghar et al. (1991) suggests a minimum tissue alpha-tocopherol concentration of at least 2.6 ug/g tissue before color, lipid oxidation, and drip loss will be enhanced, whereas some studies found tissue levels as high as 4.0 ug/g to be required. Therefore, dietary concentration of vitamin E and duration of feeding appear to play an important role in its effectiveness. Unfortunately, most studies have evaluated no added vitamin E or a relatively low concentration of vitamin E compared with a very high (200 mg/kg of feed) level and for relatively long durations. Unless additional studies are conducted to determine if a lower dosage or shorter feeding duration is equally as effective as the 200 mg/kg dosage commonly used in past studies, using vitamin E to enhance pork quality will be economically unjustified with current pork pricing programs. Interestingly, Waylan et al. (2002) observed that pigs fed modified tall oil (a source of conjugated linoleic acids) in conjunction with 110 mg/kg of vitamin E improved display color stability and reduced lipid oxidation to a greater extent than vitamin E alone. Results of O'Quinn et al. (2003) verified that modified tall oil increases the vitamin E concentrations of adipose and other tissues.

Vitamin D

Studies in beef cattle have shown that feeding high concentrations of vitamin D improves beef tenderness. Vitamin D increases plasma and muscle calcium concentrations, which in turn stimulates activity of calpains. Calpains are intracellular proteases, which have been shown to enhance meat tenderness. Enright et al. (1998) fed finishing pigs 331, 55,031, and 176,000 IU/kg of vitamin D_3 for 10 days before slaughter. Increasing vitamin D decreased daily gain (0.77, 0.67, and 0.07 kg/day) and daily feed intake (3.82, 3.63, and 2.90 kg/day). However, subjective color, Hunter L* values, and firmness improved and drip loss decreased with increasing vitamin D. Wiegand et al. (2002) fed pigs 500,000 UI vitamin D for three days before slaughter. Hunter L* values decreased and a* values increased indicating a darker, redder color after 14 days of storage. However these differences, although significant were of such a small magnitude that they were undetectable by subjective scoring. Although not statistically significant, daily gain was reduced over 50% in pigs fed high vitamin D during the three-day test period. Pork tenderness was unaffected by dietary treatment. While studies in beef cattle have seen improved tenderness with vitamin D supplementation, studies in pigs show some improvement in pork color but not tenderness. One must consider if the changes in pork color may be more of a result of the severe reduction in feed intake for several days before slaughter rather than a response attributable to vitamin D itself.

Vitamin C

Vitamin C can be metabolized into oxalic acid which has been shown to inhibit glycolysis and in turn improve pork quality (Kremer et al., 1998). In a subsequent trial, Kremer et al. (1999) fed 783 or 2348 ppm of added vitamin C for four hours before pigs were slaughtered. Short-term feeding of added vitamin C improved color scores and reduced drip loss. Providing pigs vitamin C via the drinking water for 48 hours increased plasma ascorbic acid concentrations during supplementation (Pion et al., 2003.). However, ascorbic acid and oxalic acid values quickly returned to those of control pigs when supplementation ended and there were no differences observed at the time of slaughter. No differences were observed in pork color, drip loss or lipid oxidation. Feeding added vitamin C for five days before slaughter actually increased (worsened) lipid oxidation in irradiated pork samples (Ohene-Adjei et al., 2001).

Magnesium

Supplemental magnesium has been shown to reduce catecholamine and cortisol concentrations in plasma and reduces skeletal muscle activity. Therefore, supplementing Mg to the diet should reduce the pigs glycolytic potential resulting in a high ultimate pH and improved color and water holding capacity. Some studies have shown positive responses to Mg supplementation (Otten et al., 1992; Schaefer et al., 1993; D'Souza et al., 1998, 1999; and Apple et al., 2000). These studies usually provided a bolus of Mg from one of several different sources for a short period before slaughter.

However, several studies have reported no benefit to various sources and forms of Mg supplementation (O'Quinn et al, 2000b; Frederick et al., 2003a,b,c; Hamilton et al., 2003). Such discrepancies in research findings again emphasize that other factors such as pre- and post slaughter handling and genetics must also play a greater role in pork quality than nutrition. Therefore, before implementing a nutritional strategy to improve pork quality it is imperative that it be evaluated under the conditions of your particular production chain.

Iron and Manganese

Longissimus pH and 24h L*, a*, and subjective color, marbling, and firmness scores were not affected by feeding an added 90 ppm of Fe sulfate or chelated Fe (in addition to 40 ppm of Fe sulfate in the trace mineral premix), but added Fe from either source reduced drip loss 10 to 15% (Saddoris et al., 2003). Roberts et al. (2002) observed improved color and less lipid oxidation with increasing dietary manganese up to 350 ppm, but addition of 700 ppm had no beneficial effects. In a subsequent study, added dietary manganese from up to 320 ppm had no affect on pork color or drip loss (Roberts et al., 2003).

Niacin

There has been limited research studying the effect of added niacin on meat quality. Piva (1995) reported higher reflectance values of semimembranosous muscle when feeding 75 mg/kg of added niacin to 160 kg pigs for 7 days prior to slaughter. This would indicate a greater denaturation of myoglobin, and a redder color. The authors also reported higher marbling scores when pigs were fed 150 mg/kg of niacin.

Recently Real et al. (2002) examined the effects of increasing dietary niacin on growth performance and pork quality. The first study was conducted in a university research facility with 2 pigs per pen and added niacin had minimal effects on longissimus quality measurements, although some numerical trends were apparent. The second experiment was conducted in a 1,200 head commercial research facility with 25 pigs per pen (Table 2). Added dietary niacin significantly improved meat quality, similar to the numerical trends in the first experiment. The reason for the greater response in the commercial environment is maybe due to the differences in feed intake (2.4 kg in the university environment vs. 2.1 kg in the commercial environment). Feeding added dietary niacin at 110 or 550 mg/kg niacin appeared to give the greatest response when evaluating pork quality. This was most evident in Exp. 2, especially when evaluating subjective color scores, L* values, and 24-hour pH.

Table 2. Effects of niacin on growth performance and loin quality in grow-finish pigs raised in a commercial environment (Real et al., 2002).

	Added dietary niacin, mg/kg							Contrasts, P <		
Item	0	13	28	55	110	550	SEM	Niacin[a]	Linear	Quadratic
D 0 to 117										
ADG, g[b]	760	775	762	775	754	753	6.1	0.58	0.06	0.48
ADFI, g[c]	2168	2154	2141	2070	2064	2075	27.0	0.03	0.05	0.01
G/F[c]	0.35	0.36	0.36	0.38	0.37	0.37	0.004	0.01	0.20	0.01
Longissimus										
Color[def]	3.9	3.8	3.9	3.3	4.2	4.4	0.19	0.86	0.01	0.89
Marbling[g]	1.1	1.2	1.2	1.4	1.3	1.6	0.21	0.39	0.15	0.73
Firmness[h]	2.4	2.4	2.5	2.3	2.4	2.6	0.18	0.75	0.42	0.82
Wetness[ij]	2.4	2.6	2.4	2.4	2.7	2.9	0.13	0.15	0.01	0.45
Drip loss,%[e]	2.00	1.90	1.93	1.90	1.23	0.80	0.469	0.39	0.04	0.41
L*[bj]	53.12	53.60	53.14	53.95	51.43	49.77	0.733	0.36	0.001	0.35
a*[e]	8.22	7.57	8.00	8.15	8.07	7.27	0.374	0.33	0.10	0.54
b*[e]	13.33	13.15	12.90	14.24	12.89	12.35	0.404	0.61	0.04	0.76
45 min pH	6.42	6.42	6.32	6.28	6.29	6.32	0.127	0.51	0.76	0.38
24 hr pH[fj]	5.67	5.73	5.77	5.76	5.85	5.94	0.049	0.01	0.001	0.06

[a]Control vs. added niacin.

[b]Quadratic (P < 0.06) when comparing 0 to 110 mg/kg niacin.

[c]Linear (P < 0.002) when comparing 0 to 110 mg/kg niacin; 0 vs. 550 mg/kg (P < 0.02).

[d]Scoring system of 1 to 5: 3 = reddish pink, 4 = purplish red, and 5 = purplish red.

[e]0 vs. 550 mg/kg (P < 0.10).

[f]Linear (P < 0.06) when comparing 0 to 110 mg/kg niacin.

[g]Scoring system of 1 to 10: score represents % intramuscular fat.

[h]Scoring system of 1 to 3: 1 = soft; 2 = firm; and 3 = very firm.

[i]Scoring system of 1 to 3: 1 = exudative, 2 = moist, 3 = dry.

[j]0 vs. 550 mg/kg (P < 0.01).

Drip loss percentage of the longissimus was reduced when pigs were fed 550 mg/kg added niacin. Therefore, when evaluating niacin requirements of finishing pigs based on pork quality, these data suggest that 110 mg/kg added dietary niacin will improve pork quality, with further improvements at 550 mg/kg niacin. Certainly, more research is needed to evaluate the influence of these higher levels of dietary niacin on pork quality, but they also point out differences in magnitude of response between university and commercial research environments.

Creatine

Creatine is an amino acid derivative normally produced by the liver, kidneys and pancreas from arginine, methionine, and glycine. Its function is to provide high-energy phosphate for the conversion of ADP to ATP following rapid energy expenditure, usually in the form of muscle contraction. In humans, creatine supplementation has been observed to reduce muscle fatigue and enhance performance during anaerobic exercise. Because of its role in cellular energetics, it is speculated that creatine might delay postmortem glycolysis and delay the associated drop in pH. Intracellular phosphates bound to creatine may also increase water-holding capacity. Supplemental creatine has been observed to decrease drip loss of longissimus measured 24 hours post slaughter; however results are variable in that one level of creatine or its feeding duration will reduce driploss, then values will return to those similar to controls with a different dose or duration (Berg and Allee 2001; Stahl et al., 2001; James et al., 2002). O'Quinn et al. (2000c) and Stahl et al. (2003 a,b) observed few if any improvements in pork color or driploss in pigs fed creatine.

Carnitine and Ractopamine

In 1999, Ractopamine HCl (Paylean) was approved by the FDA for use in finishing pig diets in the U.S. Extensive research has shown that Paylean improves growth performance and carcass leanness in pigs by directing nutrients away from fat deposition and towards lean deposition. The increase in protein deposition is very rapid during the first two weeks when Paylean is fed. During this time, it is possible that pigs may be in an energy-dependent phase of growth, and are not consuming enough feed to maximize protein deposition. Because of its role in fatty acid utilization, adding carnitine to the diet could increase the amount of energy available for protein deposition and increase the response to Paylean. In addition, carnitine has been shown to increase flux through pyruvate carboxylase and decrease lactate dehydrogenase in pigs. Therefore adding L-carnitine to the diet may increase pH and decrease drip loss, and thus improve meat quality. James et al. (2003a) conducted four finishing trial examining the effects of added Paylean and (or) carnitine in finishing pig diets. There were a total of 2,152 pigs used and two of the trials were conducted in university research facilities and two were conducted in a commercial research facility. The growth performance data from treatments of L-carnitine (0 or 50 ppm) and Paylean (0 or 9 g/ton) from the four trials were combined (Table 3). There were no carnitine × Paylean interactions ($P > 0.27$). Feeding pigs Paylean improved ($P < 0.01$) average daily gain and feed efficiency in these experiments. A trend was observed for increased average daily gain ($P < 0.07$) when pigs were fed carnitine compared to controls. Pigs fed carnitine in the last three to four weeks of the finisher phase also had improved ($P < 0.01$) feed efficiency compared to pigs not fed carnitine. These results suggest that L-carnitine and Paylean improve growth performance of finishing pigs.

Table 3. Interactive effects of L-carnitine and paylean on finishing pig growth performance in four trials (James et al., 2003a)[a].

	Paylean, g/ton					Probability (P <)		
	0		9					
	Carnitine, ppm							
Item	0	50	0	50	SE	Carnitine x Paylean	Carnitine	Paylean
ADG, kg	0.90	0.95	1.03	1.04	0.02	0.27	0.07	0.01
ADFI, kg	2.65	2.65	2.66	2.62	0.05	0.60	0.61	0.73
F/G	2.97	2.82	2.62	2.54	0.04	0.40	0.01	0.01

[a]Values are means of thirty-three replications from four different experiments with 2, 2, 22 to 26, and 18 to 19 pigs per pen in Exp. 1 through 4, respectively. Treatment diets were fed for 28 d in Exp.1, 2, and 3 and for 21 d in Exp. 4.

In three of the four studies, loins were collected and analyzed for standard carcass measurements, visual analyses of longissimus muscle color, marbling, and firmness, color spectrophotometry (L*, a*, and b*), drip loss, ultimate pH, and temperature at 24-h postmortem. A carnitine × Paylean interaction (P<.02) was observed for visual color, L*, and a*/b* in Exp. 1. In pigs fed Paylean, increasing carnitine decreased L* and increased visual color scores and a*/b* compared to pigs not fed Paylean. Ultimate pH tended to increase (linear, P<.07) with increasing carnitine. Drip loss decreased (linear, P<.04) in pigs fed increasing carnitine. In Exp. 2, a carnitine × Paylean interaction was observed (P<.04) for visual firmness and drip loss. Visual firmness scores decreased in pigs fed increasing carnitine and no Paylean, but increased with increasing carnitine when Paylean was added to the diet. Drip loss decreased with increasing levels of carnitine when fed with Paylean. In Exp. 3, pigs fed carnitine tended (P<.06) to have decreased drip loss.

The improvements in meat quality of pigs fed L-carnitine in combination with Paylean may be the result of carnitine's affect on the pigs' metabolic parameters either antimortem or postmortem. Carnitine has been shown to increase pyruvate carboxylase and decrease lactate dehydrogenase in pigs. An increase in pyruvate carboxylase may direct pyruvate away from lactate, thus reducing substrate for lactic acid synthesis postmortem. Furthermore, a decrease in lactate dehyrogenase may delay the onset of postmortem glycolysis. In theory, this would result in an increase in pH, and therefore darker color, better water holding capacity, and decreased drip loss. When results are compared across the three individual trials, it appears that there is a greater improvement in driploss due to added carnitine in diets containing Paylean than without (Figure 3 and 4).

Further research needs to be conducted to better understand the effects and metabolic action of carnitine on antimortem lactate levels and postmortem glycolysis. However, if further studies confirm pork quality benefits, such as decreased drip loss, increased pH, and improved meat color, or decreased serum lactate levels, the potential exists for dietary L-carnitine to be used in conjunction with Paylean in the late finishing phase.

Figure 3. **Effects of added L-carnitine (0 or 50 ppm) on longissimus drip loss (diets without Paylean: James et al., 2003b).**

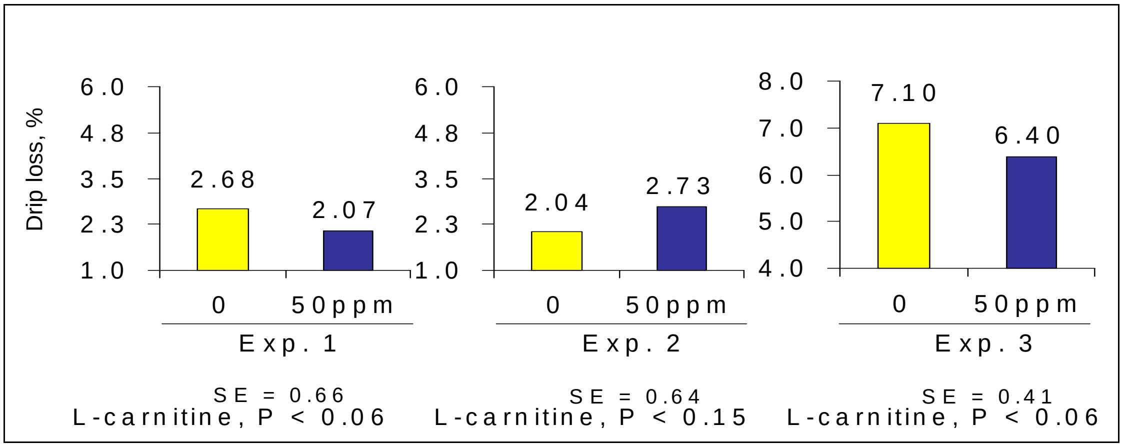
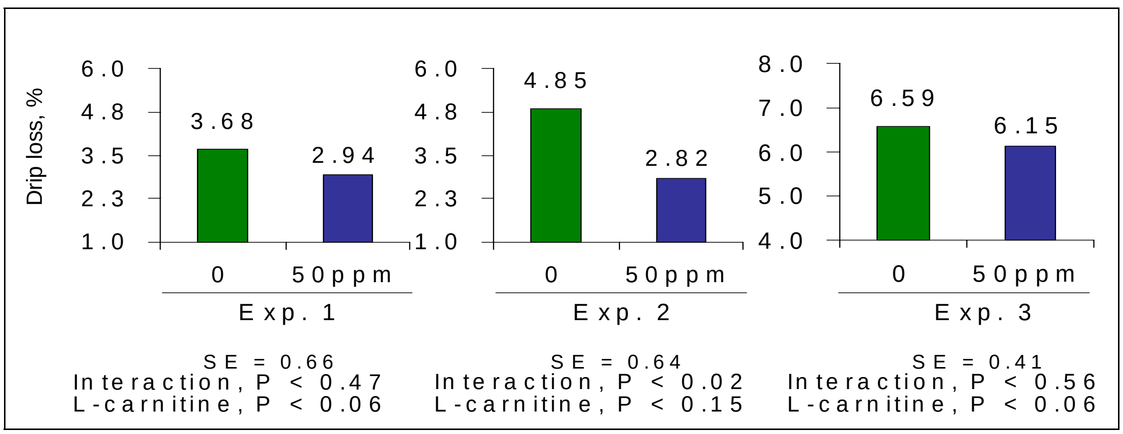


Figure 4. **Effects of added L-carnitine (0 or 50 ppm) on longissimus drip loss (diets with 9 g/ton Paylean: James et al., 2003b).**



CONCLUSIONS

1. There are several definitions of “pork quality”. A production system needs to communicate with their clientele to determine which criteria are important, and also the economic ramification from a production standpoint to implement such changes.

2. Nutrition/pork quality research is highly variable. Therefore, nutritional attempts to improve pork quality may be highly specific to a particular live animal production-packing plant system.

3. Again it is important to remember factors such as genetics and pig handling before and after slaughter will be much more important in influencing pork quality than nutrition. As our industry moves towards more and more “pumped” pork, arguable nutrition will play even less of a role in pork quality.

4. Although not as important as pre and post harvest handling, arguably there needs to be some “minimal” nutritional standard in place so as not to send an inferior product to the packing plant.

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