Abstracts from the Canadian Meat Council's 93rd Annual Conference, May 29–31, 2013, Banff, Alberta, Canada
The use of infra-red thermography for pork quality prediction

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Based on the close association between muscle temperature rise and early post-mortem pH fall rate, infra-red thermography (IRT) has been applied to detect the temperature increase in pigs in response to pre-slaughter handling with the ultimate objective to predict meat quality variation. Two experiments were carried out with the objective to determine whether IRT body temperature as measured either on dorsal or orbital regions immediately before slaughter can be used to explain variation in pork quality. In experiment 1, fore-back IRT (IRFBT) body temperature readings were taken on 133 pigs in the stunning chute while in experiment 2, 258 pigs were scanned at the ocular region (IROT) in the restrainer. Meat quality was assessed in the longissimus dorsi (LD) and semimembranosus (SM) muscles. No significant correlations were found between IRFBT and meat quality parameters in experiment 1, whereas, in experiment 2, IROT temperature recordings were correlated with pH1 (r = -0.18; P = 0.03) and drip loss (r = 0.20; P = 0.02) in the LD muscle and with pH1 in the SM muscle (r = -0.20; P = 0.02). These results indicate that higher the body and muscle temperature are before slaughter, faster is the rate of early post-mortem meat acidification. The poor prediction rate of IRFBT body temperature may be explained by the presence of dirt, hair and humidity on pig skin interfering with the temperature readings. The measurement of IRT body temperature in the ocular region may be a promising technique to predict the variation of important meat quality traits.
Evaluation of microbial dynamics on low-sodium bologna using culture-dependent and culture-independent techniques

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Recently, the meat industry has focused on overcoming the challenge of reducing salt content in foods. As a preservative, salt reduces water activity, thereby preventing food spoilage and pathogenic bacteria growth. Therefore, a reduction of salt level may affect a product’s shelf life and safety. The aims of this study were to investigate the shelf life of low-sodium pork bologna during refrigerated storage by quantifying microbial growth and diversity using culture-based and molecular techniques, and to assess the relationship between redox potential and spoilage bacteria growth. Accordingly, sliced bologna was formulated with 1, 2 and 3% NaCl. After processing, product slices were surface-inoculated with approximately $10^3$ CFU/g of a defined spoilage-bacteria cocktail. The inoculated slices were aerobically or vacuum-packaged and stored at 4°C for 30 days, during which time Lactic acid bacteria (LAB), *Pseudomonas fluorescens*, and *Brochothrix thermosphacta* bacteria were enumerated at defined intervals on de Man, Rogosa, Sharpe (MRS) agar, cephaloridine fucidin cetrimide (CFC) agar, and streptomycin thallous acetate actidione (STAA) agar, respectively. Results showed that LAB dominated from the beginning of storage, becoming most numerous after 9 d of storage under aerobic conditions and after 3 d under anaerobic conditions. *Brochothrix thermosphacta* in vacuum-packaged products at 1% NaCl reached $10^7$ CFU/g after 15 d of storage and *P. fluorescens* at 1% NaCl reached $10^6$ CFU/g after 15 d of storage with 2 logs CFU/g and 4 logs CFU/g higher values when compared with growth in the 2% and 3% salt bologna formulations, respectively. Meat Eh decreased with microbial community development. Measurement of redox potential of meat products may offer a means for real-time evaluation of microbial activity and product spoilage. A preliminary molecular analysis was carried out using Ion Torrent metagenomic sequencing based on a 16s rRNA gene target. Besides detecting the inoculated bacteria, representatives of the genera *Acidovorax*, *Serratia* and *Salmonella* were also detected. Overall, packaging conditions and salt concentration affected microbial dynamics. Under aerobic conditions, bacterial growth occurred more rapidly at lower salt concentrations, with a concurrent reduction of lag phase growth.
Utilization of flaxseed meal and microbial transglutaminase in processing of low-salt, low-fat bologna

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Microbial transglutaminase (MTG) is a food grade enzyme which catalyzes covalent cross-linking of proteins and subsequent modification of protein functionalities. However, extensive cross-linking can negatively affect water holding capacity (WHC) of meat batters. It was previously suggested that additional non-meat ingredients may compensate for this loss of WHC when MTG is added. Thus, we investigated the potential functionality of flaxseed meal (FSM) when MTG is used in processing low-sodium, low-fat bologna. Processing and sensory characteristics of twelve batches of pork bologna with different levels of FSM (0.0, 0.5, 1.0, 1.5%, w/w) and MTG (0.0, 0.15, 0.3%, w/w) were determined. Meat batters were formulated to contain 1% salt, 11.0% protein and 10% fat. The whole experiment was replicated three times and data were analyzed using Proc Mixed procedure of SAS. The addition of MTG resulted in higher purge loss ($p<0.05$) while use of FSM consistently reduced ($p<0.05$) purge loss and expressible moisture. For example, addition of 0.15-0.30% MTG increased purge by 0.7-1.2% while FSM reduced it by 0.8 to 2.6%. Interestingly, MTG did not affect WHC of bologna when measured using expressible moisture. As low as 0.15% MTG significantly increased TPA hardness, cohesiveness and springiness of bologna samples. Likewise, the trained sensory panel perceived this significant increase in firmness of samples with MTG addition. Use of 1.5% FSM increased instrumental firmness of the samples but this increase was not detected by the sensory panel. FSM negatively affected ($p<0.05$) the colour of samples both using instrumental and sensory evaluation. MTG and FSM did not affect flavour-related perceptions (i.e., foreign flavour or spice intensity). However, saltiness perception was reduced ($p<0.05$) in samples with 1.5% FSM. This study shows that MTG significantly improved texture of low-sodium, low-fat bologna but caused greater purge. Although FSM had good water binding ability and can be used in combination with MTG, its application may be limited due to its negative effect on colour, saltiness perception and handling properties (slippery surface). Nevertheless, use of alternative forms of flax products (e.g., flax protein isolate or yellow flaxseed meal with low level of mucilage) in meat processing warrants further research.
Effect of micronized chickpea flour on the physical, chemical, and sensory properties of low-fat pork bologna

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Chickpea (Cicer arietinum L.) is an economically important and highly nutritious pulse that has potential to be used as a meat binder or extender in a wide range of meat applications due to its low cost, high nutritional value and good functional properties. However, component modifications (e.g. starch and protein) by infra-red heat treatment (micronization) may improve certain functionalities to extend its efficacy as a binder or extender in meat products.

The effect of tempering (7, 15 and 22% moisture) and micronization temperature (115, 130, 150°C) of chickpea flour (5% addition level) on the physical, chemical, and sensory attributes of low-fat (<10%) pork bologna was investigated. There were no significant (p<0.05) differences of cook loss (0.32-0.43%) and expressible moisture among all bologna due to chickpea flour addition. Bologna containing chickpea flour was slightly more yellow in color (CIE system) compared with bologna with wheat flour and no binder. The bologna with 5% wheat flour showed significantly lower (p<0.05) purge losses (3.2%) than the control bologna (no binder, 5.4% purge) and all other chickpea samples (3.9-4.8%), while addition of non-micronized chickpea flour showed the lowest purge loss (3.9%) among chickpea bologna treatments. Bologna was further evaluated by instrumental texture profile analysis (TPA) which showed that chickpea flour tempered to 15% and 22% seed moisture did not improve (p<0.05) TPA hardness and chewiness of the bologna (compared with the addition of non-tempered flour) when the seed was micronized to reach 130°C and 150°C, whereas bologna produced with chickpea flour tempered to 22% following 115°C micronization had significantly (p<0.05) higher firmness as determined by both instrumental measures and sensory panelists. Results of consumer panel evaluations (101 consumers) showed the highest flavor and overall acceptability scores for bologna with micronized chickpea flour from seed tempered to 22% moisture and micronized to 115°C. As was demonstrated in this study, suitable tempering and micronization conditions are important to optimize chickpea flour functionality for incorporation into meat products such as bologna.
Packaging for retail appearance improvement of dark cutting beef

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The lost retail value from dark cutters is an economic concern for the beef industry, particularly as the number of dark-cutting beef (carcasses grading Canada B4) increased from 0.5-1.0% in 1999 to 1.5-2.5% in 2004, and because this meat is not marketable to the retail consumer. Colour is the first criterion used by the consumer when deciding on a meat purchase, and meat that is darker than normal is thought to be of inferior quality. For this reason high colour stability is essential on the retail. In this sense, some of the market could be recaptured if meat appearance could be altered. A total of 33 Normal, Borderline and dark cutting youthful carcases (pH 5.4 to <5.65, 5.65 to <6.0, 6.0 to ≈ 6.4, respectively) with marbling level and yield equivalent to the Canada AA and Y1 categories were selected from the grading line over 12 visits to a commercial plant. Carcass rib eyes and strip loins were removed, cut into steaks and packaged under carefully selected conditions to represent current common retail packaging known to be favourable for colour development in normal meat but unknown for borderline or dark cutting meat. An assortment of modified atmosphere and vacuum skin packaging (MAP and VSP respectively) which, it was thought, may have been favourable for the latter. Colour change, by digital imaging, and a number of other parameters were closely monitored over 21 days at 2°C. Results showed that packaging borderline or dark cutting steaks under a modified atmosphere of 20% CO₂: 80% O₂ (1 atm pressure) produced a bloomed colour very similar to freshly packaged Normal meat. Colour stability of Normal meat under conventional overwrap deteriorated after 3d, but was extended to 5d under 20% CO₂: 80% O₂ MAP. Colour stability of Borderline meat under the same MAP deteriorated more slowly but in a similar fashion. However, Dark meat colour remained stable for 21d. Localized discolouration, which occurred by 11d in Normal meat, occurred after 13 and 21 d for Borderline and Dark meat respectively. The appearance of dark cutting meat was successfully favourably altered using an existing packaging method. Within the wide pH range of dark cutting meat, microbial shelf life and effect on tenderness must yet be determined.
Six year trends in Canadian Bison Carcass Quality

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The importance of the bison meat industry is increasing and is expected to become a relevant alternative meat choice. As in other meat industries, the efficient use of energy, land and water will continue to be a challenge for bison producers since the global population is predicted to reach 9.5 billion people by 2050, where food requirements will increase by 70% compared with present day, and resources available for agricultural production will decrease. A review of the Canadian Bison Industry statistics over the last six years indicates notable trends in quality grades and performance. There has been a decrease in the total slaughter animals over the last six years. Although in 2012 there was a slight increase compared with the previous year (13,774 vs 12,167), the total slaughtered bison were well below the 20,000 animals slaughtered in 2007. Conversely, the average weights at slaughter have been only slightly increased (3%) during the same period but the total of overfinished carcasses, those showing more than 12 mm of fat thickness at a point ¾ of the length of the 11th rib (Canada A3 and Canada A4 together), have increased 6% (32% in 2007 vs 38% in 2012). Over the last year, carcasses with a fat thickness in the range between 2 and 6 mm (Canada A1) have decreased (35% in 2011 vs 27% in 2012). The occurrence of over finished carcasses is especially remarkable in heifers, which agrees with studies in beef reporting sex influences on the fattening patterns with heifers fattening at lighter weights than intact males. Lean carcasses are one of the strengths in the Bison industry. Over finishing carcasses will reduce the efficiency of bison production systems, since the production of fat requires considerably more dry matter intake than the production of lean, and consequently costs about four times more feed per unit gain. Therefore, efforts must be made to address the current industry trend, towards increases in fat and decreases in lean, in order to ensure production efficiency.
Storage Lives of Canadian Vacuum Packed Boneless and Bone-in Cuts of Beef

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Overseas customers for Canadian vacuum packaged beef require assurance of the product’s storage life, but little information on the storage life of vacuum package beef produced in Canada, or North America generally is available. Therefore, vacuum packaged halved strip loin and halved bone-in loin cuts were obtained from a beef packing plant and stored at 2 ºC or -1.5 ºC. Three cuts of each type were sampled when cuts were received and at sequential intervals of 10, 20 or 30 days, as was appropriate, up to 160 days of storage. The odour of each cut was assessed at pack opening, then the cut within the pack was sampled by rinsing. Numbers of aerobes and coliforms in the rinse fluid were determined. Steaks prepared from each cut were displayed and assessed daily for appearance and odour. A steak from each cut was frozen and subsequently assessed for flavour. On both boneless and bone-in cuts the maximum numbers of aerobes and coliforms were attained after about 40 days at 2 ºC or 80 days -1.5 ºC. The maximum numbers of aerobes were about 0.5 log units less, and the maximum numbers of coliforms were up to 2 log unit less on cuts stored at -1.5 ºC than on cuts stored at 2 ºC. Boneless or bone-in cuts stored at -1.5 ºC and boneless cuts stored at 2 ºC were spoiled by acid/dairy odours and flavours. Bone-in cuts stored at 2 ºC were spoiled by putrid odours associated with the bone marrow. Storage lives of strip loins were 80 days at 2 ºC or 130 days at -1.5 ºC; and storage lives of bone-in loins were 50 days at 2 ºC or 140 days at -1.5 ºC.
Survival of acid tolerant *Escherichia coli* O157:H7 on beef surfaces sprayed with 2% or 5% lactic acid

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Spraying carcasses with solutions of lactic acid is a decontaminating treatment widely used at North American beef packing plants. For HACCP purpose, the efficacy of such treatment should be validated. The utility of validation by reference to reduction in numbers of *Escherichia coli* naturally present on beef has been questioned because reductions of *E. coli* might be greater than reductions *E. coli* O157:H7, which may be more acid tolerant than *E. coli* generally. To investigate the effects of lactic acid sprays on the two types of *E. coli* on beef surfaces, slices of beef with cut muscle, fat or membrane surfaces were inoculated with a five strain cocktail of acid-adapted *E. coli* O157:H7 or with a strain of *E. coli* that was not adapted to acid, at number of 5, 1 or -1 log cfu/cm². Inoculated slices were not treated or were sprayed with water or solutions of lactic acid at concentrations of 2% or 5%. The volume of the fluids sprayed on surfaces had been shown to be in excess of the volume required for maximum reduction of the numbers of *E. coli* on surfaces. For each slice of lactic acid-treated meat the numbers of *E. coli* or *E. coli* O157:H7 recovered on agars that either allowed recovery of injured cells or recovery of only cells that had not been injured by the treatment were similar. The differences in the log mean numbers (log A) and in the log total numbers (N) of *E. coli* and *E. coli* O157:H7 recovered from slices that were not treated or were treated with acid were calculated. Also, differences in values for log A and N for the numbers of those bacteria recovered from slices treated with water or with acid were calculated. Means of the differences showed that the acid treatments gave similar reductions in the numbers of *E. coli* or *E. coli* O157:H7, but those reductions were somewhat greater with 5% than with 2% lactic acid. The findings indicate that the *E. coli* or *E. coli* O157:H7 that survived acid treatments of meat surfaces were protected from exposure to injurious concentrations of undissociated acid. Therefore, tolerance of acid conditions does not substantially increase the ability of *E. coli* O157:H7 to survive treatment of beef surfaces with solutions of lactic acid as compared with *E. coli* generally.
Effect of sodium reduction on the quality of naturally-cured ham

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There is increasing consumer awareness about dietary sodium intake and concerns over the use of chemical additives in conventionally processed foods. The meat industry has addressed this through the development of reduced salt, natural (nitrite-free) meat products. The objective of this study was to evaluate the effect of sodium reduction on quality and consumer acceptability of naturally-cured ham. Six different ham formulations were evaluated: regular salt (2.4%) ham containing sodium nitrite as a curing agent, regular salt (2.4%) and low salt (1.5%) ham formulated to contain celery powder as a curing agent, and three low salt treatments (1.5%, 1.2% and 1.2% + 2% potassium lactate) with celery powder as a curing agent and where 37.5% or 50% sodium chloride (NaCl) was replaced with a salt substitute containing potassium chloride (KCl). Hydration properties (cook yield, expressible moisture, purge during storage of vacuum packaged slices), and textural (bind force, Kramer shear force), and color (CIE L*a*b*) characteristics of ham were determined. Consumer acceptance of ham appearance, flavour, saltiness, texture, aftertaste, and overall acceptability were evaluated on separate 9-point hedonic scales. All reduced sodium formulations resulted in products with sodium contents below the Health Check™ Program limit for deli meats (i.e., 360 mg per 55 g serving). Direct salt reduction adversely affected some hydration and textural characteristics of restructured hams. However, no production issues or functionality drawbacks were encountered with any of the reduced sodium ham formulations containing celery powder when NaCl was substituted with the salt replacer containing potassium chloride. At regular NaCl levels, celery powder did not affect consumer acceptability attributes of ham samples compared to the control processed with sodium nitrite. Apart from the appearance, substitution of 37.5% of salt with KCl in nitrite-free hams did not significantly lower sensory hedonic ratings compared to control, indicating that targeted levels of sodium (<360 mg/55 g) can be achieved in some nitrite-free processed meat products without significantly compromising consumer acceptability.
Effects of the initial numbers of spores of *Clostridium estertheticum* on the development of blown pack spoilage of vacuum packaged beef of normal and intermediate pH

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Early onset blown pack spoilage (BPS) of vacuum packaged raw meat stored at chiller temperatures is characterized by gross swelling of packs at times well before the end of the expected storage life. *Clostridium estertheticum*, a strictly anaerobic spore forming bacterium, has been identified as the primary cause of early onset BPS. For BPS to develop, meat must be contaminated with spores of *C. estertheticum* rather than oxygen sensitive vegetative cells of the organism at the time of packaging. *C. estertheticum* utilizes glucose for growth on meat. The concentration of glucose in meat is related to the meat pH. Therefore, to understand how the initial numbers of spores of *C. estertheticum*, and the concentration of glucose in meat affect the development of BPS, steaks of normal (5.4-5.6) and intermediate (5.7-5.9) pH with surface areas of about 200 cm² were inoculated with peptone water or spore suspensions to obtain 0, 3, 10, 30, 100, 300 or 1000 spores/pack. After vacuum packaging, the packs were stored at 2°C for up to 110 days. The volumes of packs were determined by water displacement when storage commenced and at 2-3 week intervals. For packs containing normal pH meat that had been inoculated with 0, 3 or 10 spores, none of the three packs slackened or swelled and the maximum change in pack volumes was ≤11 ml. The packs that had been inoculated with 30, 100, 300 or 1000 spores/pack started to swell after 35 d of storage with linear rates (R²≥0.94) of increase of volume with time. The rates of volume increase decreased with decreasing numbers of inoculated spores. Maximum increases in packs volumes of about 670 ml were attained by only the packs inoculated with 1000 spores/pack. Packs containing intermediate pH meat that had been inoculated with 0, 3, or 10 spores/packs slackened during storage, with maximum increases of ~50, 55 and 65 ml after 80 d, 80 d and 93 d, respectively. The packs that had been inoculated with 30, 100 or 300 spores or 1000 spores became moderately distended, with maximum increase in volumes of 115 ml and 185ml, respectively. Thus, the minimum numbers of spores that could cause early onset BPS of vacuum packaged beef are >10 <30 spores/200 cm² and pack distension is greater with beef of normal than of intermediate pH.
The Impact of Sodium Reduction Strategies on the Sensory and Processing Characteristics of Meat Products

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The demand for reduced sodium foods continues to be a major trend for Canadian consumers. For processed meats, sodium chloride reduction can be challenging because of its importance for proper functionality, microbial stability, and sensory properties. Nevertheless, strategies continue to be explored that will best allow the meat industry to respond to consumer demands. Four treatments were evaluated in 2 meat systems (restructured ham and turkey smokies) for their ability to effectively reduce sodium, yet maintain good sensory properties (2 salt replacers (SRs) [Ocean's Flavor Sea Salts - OF45, OF60], 1 savoury flavour enhancer [Fonterra™ 'Savoury Powder' (SP)], and sodium chloride (NaCl) reduction [40% and 50% reduced sodium for ham and smokies, respectively (LS)]). Product functionality and safety were assessed using instrumental measures (yield, purge, pH, expressible moisture, proximate composition, sodium content, colour, texture) and microbiological assessment. Sensory attributes were evaluated using consumer and trained sensory panellists. In both systems, SRs were perceived as less salty and more bitter compared to control, especially for OF45, where an off aroma-induced enhancement of bitterness is postulated. SP was either lower or no different in flavour and saltiness compared to LS, suggesting its capacity for flavour enhancement may be less than optimal in these systems. Consumer hedonics for flavour, saltiness, and aftertaste was lowest for OF45, suggesting that this SR may not be appropriate for inclusion in these products. All non-control treatments in both restructured ham and turkey smokies resulted in products with sodium contents below the Health Check™ Program limit for deli meats. Direct NaCl reduction adversely affected some hydration and textural characteristics of restructured hams and turkey smokies, however, no detrimental effect on water binding and texture was observed when NaCl was substituted with sea salt replacers (OF45, OF60). Sodium reduction had no effect on the shelf life of the cooked ham and smokies with up to 60 days of refrigerated storage.
Numbers of *E. coli*, non-O157 STEC, F-RNA Coliphage, Rotavirus, Bovine Enteric Calicivirus on Commercial Vacuum Packaged Beef

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The Canadian beef industry has greatly improved the safety of beef and the numbers of generic *E. coli* have been reduced to very low levels. *E. coli* O157:H7 and non-O157 shiga toxigenic *E. coli* (STEC) can be transmitted through undercooked beef while concerns have been expressed about the zoonotic transmission of animal strains of norovirus (bovine enteric calicivirus, BEC) and rotavirus (RV) but these viruses cannot be cultured. F-RNA coliphages are likely to be deposited on meat along with other enteric organisms during carcass dressing and processing and may be regarded as an indicator for contamination with potential zoonotic enteric viruses. F-RNA phages can be genotyped to differentiate human from animal sources. The objective was to determine the numbers of *E. coli*, non-O157 STEC, F-RNA phages, BEC and RV on samples obtained from the entire surfaces of 150 vacuum packaged beef subprimals originating from federally and provincially registered plants that were purchased at retail. Hydrophobic grid membrane filtration was used to enumerate *E. coli* and replicate filters were used as templates to detect STEC by colony hybridization. Infectious F-RNA phages were detected by plaque assay and F-RNA phage, BEC and RV RNA were detected by real time RT-qPCR. The prevalence and log mean numbers of *E. coli* were higher in provincially than in federally registered plants while the opposite was true for viable F-RNA coliphages. One presumptive positive STEC (*stx*₂ and *eae* positive) sample was identified. Viable F-RNA phages of human origin were detected in 12% and 30% of samples that originated from provincially and federally regulated plants, respectively. F-RNA phage RNA was detected in one sample (0.7%) at a low level and BEC RNA was not detected. RV RNA was detected in 4% of samples from both federally and provincially registered plants at levels ranging from 2200 to 21000 genome copies/subprimal. The presence of viable F-RNA phages suggests that consumers could potentially be at risk when consuming undercooked meat that is contaminated with RV. This is the first study to report RV RNA on meat.
Effect of multiple vacuum packs on colour development and stability in beef steaks

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Vacuum packaging is used routinely as a means of preserving the freshness of meat but may influence meat colour stability. Although multiple vacuum packaging is not frequent in industry, logistical requirements (re-branding, portion control) sometimes make re-packaging necessary. The aim of this study was to compare the colour stability of steaks from longissimus muscle submitted to four treatments of vacuum packaging to simulate potential leaks/re-packaging and aged for 15 d. Muscle portions were either vacuum packed and aged for 15 d (NRP), repacked after 2 h (RP2h), 8 d (RP8d), and after 2 h and 8 d (RP2h+8d). Purge loss values from RP8d and RP2h+8d treatments were higher ($P = 0.02$) than those from NRP and drip loss was higher ($P < 0.01$) for RP2h and RP8d. Colour changes during a 30 min period of exposure to atmospheric oxygen immediately after opening the packages were similar for repackaged-aged steaks and NRP steaks ($P > 0.05$). Nevertheless, colour stability during subsequent retail display was affected by the packaging treatment. The decrease in $a^*$ and chroma values ($P = 0.01$ and 0.04, respectively) and the increase in hue ($P = 0.01$) between day 3 and 6 was minimal for RP2h+8d, compared to NRP, RP2h and RP8d. Also, the proportion of pigment in the reduced myoglobin form in these three treatments dramatically increased from day 3 to day 6, while no effect was observed for RP2h+8d ($P <0.01$). Similarly, the decrease over time in the proportion of pigment in the oxymyoglobin form in meat from the RP2h+8d treatment was much lower ($P < 0.01$) than for the other three packaging treatments. Vacuum packaging more than twice depleted the enzyme activity of metmyoglobin reductase, reducing colour stability during retail display. Thus, although specific conditions requiring multiple vacuum packaging are infrequently encountered in industry, the potential impact on subsequent beef colour needs to be well understood.
Enhanced selectivity of viable real-time PCR for *Escherichia coli*

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To enhance control over microbiological contamination at meat packing plant, early detection of increasing numbers of indicator organisms, e.g., *Escherichia coli* is highly desirable. The DNA intercalating dye propidium monoazide (PMA) can selectively inactivate DNA in dead cells, i.e., membranes compromised cells, and is used in conjunction with real-time PCR to enumerate live bacteria, often referred as viable real-time PCR. However, the use of viable real-time PCR for testing of meat plant samples is limited because PMA is not able to penetrate *E. coli* that is inactivated but still has intact cell membranes, which is often the case for the *E. coli* populations after decontamination treatments routinely applied in meat packing plants. The aim of this study was to increase the accessibility of DNA to PMA in *E. coli* that is inactivated by mild heat treatment and thus improve the discriminatory power of viable real-time PCR. Therefore, 12 emulsificants were tested for their selective permeation to PMA of only dead *E. coli*. Suspensions (~10^6 cfu/ml) of an overnight culture of *E. coli* inactivated by incubation at 52°C were treated with one of the 12 emulsificants. The DNA from cells in the suspensions was quantified by viable real-time PCR. The treatment with deoxycholate and sarkosyl had increased the cycle thresholds (Ct) values by 6.84 and 8.47 Ct, respectively. The treatment with chenodeoxycholate, glycodeoxycholate and glycochenodeoxycholate resulted in increases of Ct values by 3.49, 4.19, and 4.17, respectively. The treatment with the other 7 emulsificants had little effects (ΔCt < 2.0). In conclusion, treatments with sarkosyl or deoxycholate was very effective on rendering permeability to PMA of mild heat inactivated *E. coli* and thus could be incorporated into viable real time PCR for enumeration of *E. coli* that survive mild heat treatments.
Impact of genetics and feeding on loin marbling levels of Canadian hogs

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Intramuscular fat (IMF) is known to be highly heritable but is also strongly influenced by feeding strategies. Since 2009, loin IMF predicted on live pigs using ultrasonic scanning has been included in the Canadian swine technician accreditation program and in genetic evaluations for Duroc pigs. A research project involving 6,000 Duroc pigs scanned across Canada was designed to broaden the live IMF database and confirm genetic parameters estimated in a previous study. Data collected in the project were also used for genetic evaluation and selection of Duroc boars with extreme (high or low) breeding values for IMF to produce commercial pigs tested in two research trials (in Western and Eastern Canada) using a 2x2 factorial design. Pigs from each group were fed either a standard diet specific to the region, or a special diet formulated to increase marbling deposition. A total of 687 pigs were performance-tested from weaning to slaughter, and tracked at the packing plant for a full carcass and meat quality evaluation. Special feed increased loin IMF (+0.4 to +0.6%), backfat by 1 to 2 mm and decreased lean depth by 2 to 4 mm. It also decreased growth rate by 40 to 50g/day. Using boars with high IMF EBVs allowed increasing loin IMF by 0.3 to 0.5% in these trials without yielding any adverse effects on growth and carcass quality. No statistical differences on other meat quality traits (pH, drip loss or colour) were observed between boar groups or feeding programs. A sensory analysis was also carried out on a subset of loins. Pork from the most marbled group (produced with boars with high potential for IMF and using a special feeding program) was evaluated as more tender and palatable than pork from the other three groups. The project provided valuable information about the effect of genetics and management (especially feeding) on marbling levels in pork loins. Moreover, Canadian pig producers now have new tools to customize marbling levels in their hogs using a combination of genetics and feeding.
Potential for a Genetic Solution to Boar Taint in Canadian Pigs

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Alternatives to castration as a means of avoiding high boar taint levels in pork are being sought, in part due to concerns for welfare of piglets and due to market demands. It has been suggested that genetics can help to reduce boar taint levels by changing the frequency of genetic markers in genes involved in the synthesis and degradation of androstenone and skatole, the two main compounds responsible for boar taint. A project was designed to genotype 300 pigs per breed (Landrace, Yorkshire and Duroc) to assess SNP marker allele frequencies and test the potential association of the SNP markers with economically important performance traits. In addition, 700 boars per breed were also planned to be genotyped, measured for boar taint compounds when weighing more than 90 kg of live weight, and to estimate SNP marker effects. Androstenone and skatole levels were determined from fat samples using ELISA and HPLC, respectively. To date, androstenone has been measured on 147 Duroc, 262 Landrace and 288 Yorkshire pigs with an average (range) of 1,718 (243-12,077), 949 (126-8,720) and 988 (157-7,747) ng/g, respectively. Average skatole (range) in 114 Duroc, 208 Landrace and 268 Yorkshire pigs was 66.0 (0-1016), 111.7 (0-754) and 90.5 (0-3502) ng/g, respectively. Considering the acceptable thresholds of 1000 and 200 ng/g for androstenone and skatole, 34% and 11% of the samples exceeded the acceptance level for androstenone and skatole, respectively. Animals were genotyped for 77 SNPs out of an initial 122 selected candidate SNPs. Preliminary analysis found 52, 69 and 70 SNPs had minor allele frequencies greater than 1% in a sample of 316 Duroc, 493 Landrace and 513 Yorkshire pigs, respectively. Observed variation of boar taint compounds and genotype frequencies support the potential of using genetics to lower boar taint levels in Canadian pigs. Association analysis will be followed by validation of predicted androstenone and skatole levels compared to actual phenotypes on an independent sample of 900 additional boars.
Effects on carcass quality of a compensatory growth strategy with use of by-products in fattening pigs

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Reducing the production costs in pig production is a serious concern for the whole swine industry, including processing sector. The incorporation of by-products (BP) in the feed and the use of a feeding strategy based on compensatory growth (CG), which consists in a feed restriction followed by a grow up, are known to reduce the production cost. The objective of this study was to measure the impact of CG on carcass characteristics and meat quality of pigs fed diets containing between 30 and 40% of BP (DDGS, canola meal and wheat shorts). A total of 72 pigs from a fat breeding scheme (FAT; barrows = 18, females = 18) and a lean breeding scheme (LEAN; barrows = 18, females = 18) were used. At an initial weight of 25 kg, pigs were randomly assigned to one of three dietary treatments, until slaughter at 120 kg. The control group received feed containing no BP and was not exposed to CG; the BP group received feeds containing BP, but was not subjected to CG and finally, the animals of the BP + CG group were fed with BP and were subjected to CG. The CG was induced by a 30% restriction of digestible lysine, phosphorus and calcium, from d 14 to d 28. Pigs had ad libitum access to water and feed throughout the trial until slaughter. Quality measures on carcass and meat were done on a sample of the longissimus dorsi muscle 24 h postmortem. The results showed that the animals of the LEAN breeding scheme had a lean yield 3% higher and a loin eye area 4.5 cm² higher than the animals of the FAT breeding scheme. However, their meat was less red and showed lower marbling (P < 0.05) than the FAT pigs. Carcass weight and backfat thickness were higher in barrows but the lean yield was 2.2% lower compared to females (P < 0.05). It was also observed that the presence of BP led to a decrease in the muscle depth, drip loss and meat marbling (P < 0.05). No significant difference was observed between BP + CG and BP groups, which means that CG had no effect on carcass characteristics and meat quality. According to those results, a feeding strategy using compensatory growth coupled with the incorporation of by-products in feeds has little effect on quality measurements in fattening pigs.