Abstracts for the Functional Foods and Natural Health Products
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The impact of dairy intake on fatty acid and lipid profiles in healthy adults from two Canadian cities: 'progress-to-date' remarks
Abdullah, Mohammad MH; Pallister, Tess; Jones, Peter

Objectives Dairy foods have been a marked piece of the mankind diet for millennia. Interestingly, however, there remains a confusing picture of evidence on the causal link between the intake of dairy and classic risk factors of public health concerns, such as high circulating cholesterol levels. This may be due, in part, to an array of fatty acids (FA) that have been shown to exert contradictory wellbeing outcomes. This multicentre study sought to assess the influence of consuming dairy products on circulating FA profiles, and thus association with impacts on cholesterol levels and/or other cardio-metabolic risk indicators. A deeper look into the contributing metabolic and genetic factors was also considered.

Activities, methods, innovations A free-living randomized crossover trial of 2 dietary phases (4 wks each), separated by 4-8 wk washout period, was carried out in Winnipeg and Quebec City. As part of a healthy-style background diet, participants (n= 120) were asked to consume 3 servings/d of conventional dairy products (low-fat milk, low-fat yogurt, and regular cheddar cheese) or energy-equivalent control products (fruit juice, vegetable juice, cashews, and a cookie). Circulating FA and lipid profiles were assessed by standardized techniques.

Outcomes, results, lessons learned This study is ongoing. Preliminary data suggest that short-term intake of the dairy, but not control, products modified circulating levels of certain polyunsaturated and saturated FAs. Moreover, the study detected significant correlations between the dairy consumption and plasma levels of medium chain FAs. This may explain some of the reported beneficial impacts of dairy intake on health.

Effect of Conjugated Linoleic Acid on High Glucose-Induced Hypertrophy and Dysfunction of Cardiomyocytes
Aloud, Basma M.; O'Hara, Kimberley A.; Shao, Zongjun; Anderson Hope D.

Objectives - Our laboratory has shown that conjugated linoleic acid (CLA; a naturally-occurring polyunsaturated fatty acid) prevents myocyte hypertrophy in vitro and in vivo. These cardioprotective effects were mediated through activation of peroxisome proliferator activated receptors (PPARs). Thus, the objectives of this study were to determine the effects of CLA on diabetic cardiomyopathy, and to assess the role of PPARs.

Methods - To model hyperglycemia, adult rat cardiac myocytes were treated with normal (5 mM) and high glucose (25 mM) concentrations. Subgroups of myocytes were also pretreated with vehicle or CLA (30 µM) in the presence and absence of a
PPARγ antagonist (GW9662; 1 µM). The effects of CLA on hyperglycemia-induced myocyte hypertrophy were assessed by measuring augmentation of myocyte size, de novo protein synthesis, and fetal gene expression. Contractile properties of ventricular myocytes were assessed by measuring maximal velocity of shortening and relengthening using the Ionoptix HyperSwitch Myocyte System.

**Results** - Treating adult rat cardiomyocytes with high glucose increased cardiomyocyte size and protein synthesis compared to untreated cells. Hyperglycemia-induced cardiac myocyte hypertrophy was attenuated by pretreatment with CLA. The ability of CLA to prevent hyperglycemia-induced hypertrophy was abolished by pretreatment with GW9662. High glucose also impaired contractile function of adult rat myocytes as measured by maximal velocity of shortening and relengthening. Hyperglycemia-induced contractile dysfunction was prevented by pretreatment with CLA.

**Conclusions** - Collectively, these findings indicate that CLA prevents cardiac myocyte hypertrophy and impairment of contractile function. These cardioprotective actions of CLA are likely mediated, at least in part, by activation of PPARγ.

**Calcium enrichment of cheddar cheese: effect on its structure and in vitro digestion**

**Ayala-Bribiesca, Erik; Turgeon, Sylvie L.; Britten, Michel**

Cheddar cheese is an excellent source of calcium. Calcium has a structuring effect on the paracasein gel and influences the bioaccessibility of fatty acids in the intestine. The effect of calcium on the cheese matrix was studied to better understand its impact on in vitro bioaccessibility of fatty acids.

Cheddar cheeses were enriched with CaCl2 during the salting process. Cheeses were characterized by physicochemical analysis, texture analysis, confocal laser and scanning-electron microscopy. During the in vitro digestion of cheeses, the rate of physical disintegration and lipolysis were followed.

Calcium fortification of cheeses reduced their water content due to an osmotic dehydration after the salting procedure. Consequently, hardness was higher for cheeses enriched with a higher concentration of calcium. Images obtained by microscopy showed a more contracted protein structure, possibly associated with the loss of moisture in cheeses fortified with calcium. This protein structure contraction would be responsible for the coalescence of fat globules in the matrix. During in vitro digestion, physical disintegration of enriched cheeses was slower than that of the control. The extent of lipolysis was not influenced by the calcium content of cheese, but higher calcium fortification did lead to faster lipolysis rates. These results highlight the role of calcium on the cheese matrix and its modulatory role in lipid bioaccessibility. Studies on the interactions of calcium with lipids under digestive conditions are in progress. This will eventually lead to the development of dairy matrices that can modify the metabolic response and act as vehicles for bioactive molecules.
EFFECT OF DIFFERENT DIETARY OILS ON PLASMA ADIPONECTIN CONCENTRATIONS: A RANDOMIZED CROSSOVER CONTROLLED INTERVENTION

Baril-Gravel, Lisa; Richard, Caroline; Couture, Patrick; Jenkins, David A.; West, Sheila; Kris-Etherton, Penny; Jones, Peter; Lamarche, Benoît

OBJECTIVE: We investigated in the COMIT Study the impact of oils containing various amounts of alpha-linolenic acid (ALA), linoleic acid (LA), oleic acid (OA) and docosahexaenoic acid (DHA) on plasma adiponectin concentrations.

METHODS: In this multicenter, double-blind, randomized, crossover controlled feeding study, 99 healthy men (n=45) and women (n=54) with abdominal obesity and moderate hypertriglyceridemia, aged 18-68 y were fed 5 isoenergetic diets (15.5% protein, 35.7% fat, 50.6% carbohydrate) of 4 weeks each, separated by 4-week washouts. Each diet incorporated 60g/3000kcal of different dietary oils (table). Plasma adiponectin concentrations after each diet were compared using mixed models.

RESULTS: CanolaDHA was the only oil associated with significant increase in plasma adiponectin concentrations compared with the Control oil (+4.8%, P=0.01). Consumption of Canola (+5.1%, P=0.01) and CanolaOA oils (+3.1%, P=0.04) also increased plasma adiponectin compared with the Flax oil.

CONCLUSION: These data from COMIT suggest that: 1- ALA on its own has no effect on plasma adiponectin, 2- OA replacing ALA and LA increases adiponectin, 3- combination of OA and DHA is associated with the highest adiponectin concentrations. Implications of such changes in adiponectin in terms of cardiovascular risk require further investigation.

Evaluation of antibacterial and antioxidant activities of carotenoids extracted from seaweed Ascophyllum nosodum, Saccharina longicruris and Ulva lactuca.

Boisvert, Catherine; Beaulieu, Lucie; Pelletier, Émilien.

The marine environment represents an unlimited source of metabolites having a high potential in biotechnology notably as new original bioactive compounds. Marine biomass constitutes valuable and nutritional sources of bioactive molecules for future applications in various fields such as nutraceuticals and functional foods as well as applications in preventing bacterial contamination of food products or cosmetics. This project has achieved the production and characterization of extracts originating from several marine seaweeds. Our hypothesis is that the pigments, specifically the carotenoids, extracted from Ascophyllum nosodum, Laminaria longicruris and Ulva lactuca possess potential antioxidant and antibacterial activities. The antioxidant potential of the total fraction of each seaweed, obtained by pressurized liquid extraction at 80 and 50 °C, was evaluated using the ORAC, DPPH and FRAP methods. The antibacterial activity was determined by the
microdilution method in microplates using the bacterial strains Micrococcus luteus, Brochothrix thermosphacta, Escherichia coli and Listeria innocua which are of interest in the food sector. A more specific characterization of carotenoids, which have exhibited potential antibacterial and antioxidant activities, was carried out by HPLC following a subsequent fractionation step. Preliminary results indicated that several different antioxidant mechanisms could be involved regarding the kinetics observed for DPPH and FRAP methods.

**Control of Listeria monocytogenes in meats**

Boualem, K; Subirade, M.; Guernec, A. and Saucier, L.\(^1,2\)

*Listeria monocytogenes* is amongst the 10 microorganisms most often incriminated in food borne diseases. We are currently investigating new and more natural strategies to control *L. monocytogenes* in meat processing including the use of essential oils (EO; ground meat, marinade, ham) and the development of an effective encapsulation system allowing the controlled release of nisin in meat. The antimicrobial activity of the EO against *L. monocytogenes* was determined *in vitro* by spot-on-lawn assays and *in vivo* when the meat was inoculated with a cocktail of five strains of *L. monocytogenes* at a concentration of 4 log cfu/g. Our results indicate that an inhibition of up to 4 log CFU/g is obtained with 2% thyme EO in marinated meats and research is underway to determine its efficacy in ham. Nisin is a small peptide produced by *Lactococcus lactis* spp. *lactis* that is active against *L. monocytogenes*. This peptide loses its activity in meat due to enzymatic degradation by proteases or by reacting with glutathione. To protect and control the release of nisin, liposomes prepared from dipalmitoylphosphatidylcholine (DPPC) were used to encapsulated nisin. Encapsulated nisin assays did not result in the formation of inhibition zones in raw meat indicating that nisin remained in the capsule until heat treatment is applied and melt the liposome. After cooking at a core temperature of 71°C, a release of nisin in cooked meat was observed and confirmed by the formation of inhibition zones.

**Prudent and Western dietary patterns alter the gene expression profile of healthy men and women.**

Bouchard-Mercier, Annie; Paradis, Ann-Marie; Rudkowska, Iwona; Lemieux, Simone; Couture, Patrick; Vohl, Marie-Claude

Diet regulates gene expression profiles. The objective is to examine gene expression in relation with the Prudent and Western dietary patterns. **Methods:** 30 Caucasians (13 males; 17 females) participants were recruited. Dietary patterns were derived from a food frequency questionnaire using factor analysis. RNA was extracted from peripheral blood mononuclear cells (PBMCs), when subjects were in the fasting state. Expression levels of 47 231 mRNA transcripts (> 31000 genes) were assessed using the Illumina Human-6 v3 Expression BeadChips®. Microarray data was analysed with Flexarray software and Ingenuity Pathway Analysis (IPA). **Results:**
The Prudent pattern was characterised by high intakes of vegetables, fruits, whole grain products, non-hydrogenated fat and fish. The Western pattern was characterised by high intakes of refined grain products, processed meats, desserts, added sugars and snacks. In subjects with high versus low scores for the Prudent pattern, 276 transcripts were upregulated and 255 were downregulated. In subjects with high versus low scores for the Western pattern, 211 transcripts were upregulated and 258 were downregulated. IPA reveals that genes differentially expressed were present in networks related to inflammatory response and cancer. 

**Conclusion:** Studying gene expression profiles according to dietary patterns may help to understand the overall effect of nutrition for chronic disease prevention. CIHR (MOP229488)

**The Selective Production of 13-HOTrE, a 15-Lipoxygenase Product and Renoprotective Octadecanoid**

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Background: The fatty acid metabolites, docosanoids, octadecanoids, and eicosanoids, play a crucial role in renal health and disease progression. The renal eicosanoid lipidome and the potential influence of diet have yet to be elucidated.

Methods: Diet-induced obese rats consumed a high fat diet (lard/soy oil 55% energy) for 12 weeks to induce obesity; subsequently the rats were divided among 7 diets containing various levels of ALA and LA (linoleic acid) as follows: (g ALA/LA per 100 g oil) canola/flax-(22/19), canola-(11/21), soy-(8/54), high oleic canola/canola-(7/21), high oleic canola-(3/20), lard/soy-(1/9), and safflower-(1/75). Histology, LC-MS/MS, and Western immunoblotting detected early obesity-related glomerulopathy, the eicosanoid lipidome, and protein levels of enzymes, respectively.

Results: LC-MS/MS detected 33 renal eicosanoids, docosanoids, and octadecanoids, of which the novel ALA derived octadecanoid, 13-hydroxyoctadecatrienoic acid (13-HOTrE) was detected.

The various diets did not alter protein levels of 15-lipoxygenase, the enzyme responsible for 13-HOTrE, 13-hydroxyoctadecadienoic acid (13-HODE) and 15-hydroxyeicosatetraenoic acid (15-HETE) production. Two factors did influence their production, substrate quantity and enzyme selectivity. Substrate levels influenced 13-HOTrE \( (r=0.87) \) and 13-HODE \( (r=0.77) \) production; the selectivity of renal 15-lipoxygenase also influenced renal octadecanoid and eicosanoid production. When normalized for nmol% of fatty acids, 15-lipoxygenase appeared to produce significantly more 13-HOTrE than 13-HODE and 15-HETE \( (p<0.0001) \) by 4 and 13 times more, respectively. Interestingly, renal HOTrE levels were correlated to glomerular volume \( (r=-0.3) \).

Conclusion: The novel octadecanoid, HOTrE, is influenced by dietary ALA, is preferentially produced over 13-HODE and 15-HETE, and may play a role in preventing glomerular hypertrophy in obesity.
**Antimicrobial activity of mustard meal against *Saccharomyces cerevisiae***

Cordeiro, Roniele; Belisle, Breanna; Holley, Richard

This study investigated the ability of *Saccharomyces cerevisiae* to hydrolyze the glucosinolate sinigrin in oriental mustard powder to form the antimicrobial allyl isothiocyanate (AIT). The antimicrobial action of AIT and mustard powder against *S. cerevisiae* were also examined. High-performance liquid chromatography (HPLC) was used to assess hydrolysis of sinigrin by *S. cerevisiae* over 13d. The minimum inhibitory concentration (MIC) of AIT against *S. cerevisiae* was tested in de Man, Rogosa and Sharpe broth (MRS) contained in capped glass tubes at 30°C with shaking (200 rpm). For testing the antimicrobial activity of mustard, MRS broth was prepared with and without 2% (w/w) oriental mustard and incubated at 35 °C with shaking. Yeast populations were enumerated after 7 days on MRS agar. HPLC analyses showed that *S. cerevisiae* has myrosinase-like activity and hydrolyzed 447 ppm of sinigrin to form AIT. The MIC of AIT against *S. cerevisiae* was 103 ppm. Two % (w/w) oriental mustard was able to reduce *S. cerevisiae* by 3 Log CFU/ml after 7 d. The higher myrosinase-like activity found in *S. cerevisiae* than in bacteria suggests the yeast may have value when combined with mustard as an antimicrobial precursor system in food to continuously form AIT, which is potent but highly reactive (unstable). *S. cerevisiae* might also be used for degradation of glucosinolates in rapeseed and mustard for the feed industry.

**ASSOCIATION BETWEEN POLYMORPHISMS IN THE FADS GENE CLUSTER AND THE PLASMA TRIACYLGLYCEROL RESPONSE TO AN Ω-3 PUFA SUPPLEMENTATION***

Cormier, Hubert; Rudkowska, Iwona; Paradis, Ann-Marie; Thifault, Elisabeth; Garneau, Véronique; Lemieux, Simone; Couture, Patrick and Vohl, Marie-Claude

The purpose of the present study is to increase knowledge about the effects of a supplementation with omega-3 (ω-3) polyunsaturated fatty acids (PUFA) on lipid profile in relation to the presence of single-nucleotide polymorphisms (SNPs) in the *FADS* gene cluster. Plasma lipid levels were measured in 122 subjects prior and after a 5 g/d fish oil (including 3 g/d of ω-3 PUFA) supplement for 6-weeks. DNA was extracted and then genotyping of 19 SNPs (covering 100% of the *FADS* gene cluster area) was performed using TaqMan technology. The ω-3 PUFA supplementation had an independent effect on plasma TG levels, as expected. Thirty-six individuals (29.6%) were classified as non-responders, meaning there was no reduction of plasma TG levels, and eighty-six (70.4%) were responders. Two SNPs (rs174546 and rs174611) were significantly associated (p ≤ 0.05) with plasma triglyceride (TG) levels, before and after the supplementation. These results suggest that SNPs influencing plasma TG levels are also those influencing the plasma TG response to a TG-lowering therapy.
Medium chain triglycerides (MCT) supplementation stimulates ketogenesis in healthy adults.
Courchesne-Loyer, Alexandre; Fortier, Mélanie; Tremblay-Mercier, Jennifer; Filteau, Conrad; Cunnane, Stephen C.

One of the earliest manifestations of Alzheimer’s disease is a marked brain glucose hypometabolism. Ketone bodies, which are produced from fatty acids in the liver, are the brain’s alternative source of energy to glucose. Medium chain triglycerides (MCT) are fatty acids that are rapidly metabolised into ketones. A single dose of MCT increases, transiently, plasma ketone concentrations and can restore cognition in cognitively-impaired patients. Objective: To assess the effects of a one month MCT supplementation on ketonemia in healthy adults. Methods: Eight healthy participants (26 ± 1 y) were given a 4 week MCT supplementation (60 g/d). Ketones, glucose, triglycerides, cholesterol, free fatty acids and insulin were measured. Ketones and MCT catabolism were also measured in breath by measuring 13C2 enrichment by 13C-beta-hydroxybutyrate (ketone) and 13C-trioctanoate (MCT). Results: Over 24 h, averaged, plasma ketones increased 3 fold over baseline (from 123±13 to 476±152 μM, p<0,001) following the initial MCT dose. 13C-beta-Hydroxybutyrate β-oxidation was not influenced by the MCT supplementation, but a change in 13C-trioctanoate β-oxidation was noted. No other changes or adverse effects were noted. Conclusion: MCT supplementation seems to be able to maintain mild ketonemia in adult subjects without any deterioration of the plasma lipid profile or weight gain. A strategy to combine MCT with a fibrate is in progress with the goal of obtaining higher but still mild ketonemia (1-2 mM), which we calculate is probably necessary to achieve cognitive benefits in the elderly. (The CFI, CRC, and NSERC are thanked for financial support.)

IMPACT OF DAIRY PRODUCTS CONSUMPTION ON BLOOD PRESSURE IN HEALTHY SUBJ ECTS WITH LOW GRADE INFLAMMATION
Cyr, Audrey; Abdullah, Mohammad; Richard, Caroline; Jones, Peter; Couture, Patrick; Lamarche Benoît

Objective: To investigate the impact of dairy consumption on systolic (SBP) and diastolic blood pressure (DBP) in men and women with low grade systemic inflammation. Methods: This multicenter single-blind randomized crossover study included 125 men and women aged between 18-70 y with CRP values > 1 mg/L. As part of prudent 4-week diets, participants were asked to incorporate dairy products (375 ml/d of low-fat milk, 175g/d of low-fat yogurt and 30g/d of regular cheddar cheese) or energy equivalent control products (290 ml/d of fruit juice, 156 ml/d of vegetable juice, 20g/d of cashews and one cookie). Each 4-week diet was consumed in random order and separated by 4-8 week wash out. Blood pressure was measured twice, at two different visits at the end of each diet. The mean of the two measurements was used for analysis. Results: Overall, the DAIRY diet had no
impact on weight and waist circumference compared to the CONTROL diet. The DAIRY diet had no significant impact on SBP compared with the CONTROL diet (110.0±12.9 vs. 109.9± 13.5 mmHg, P=0.91). However, SBP was reduced significantly among subjects with SBP>120 mmHg compared to those with SBP<120 mmHg (-2.5%, P=0.04 vs. +0.9%, P=0.17 respectively, P for interaction=0.007). There was no change in DBP with the DAIRY diet (P=0.15). **Conclusion:** These preliminary data suggest that short-term intake of 3 servings of dairy products per day reduces SBP in subjects with subclinical inflammation and with SBP values above 120 mmHg.

**Influence Source of Protein on Effect of High Protein diet on Kidney in Obese Rats**

**Devassy, Jessay Gopuran; Wojcik, Jennifer; Ibbrahim, Naser; Aukema, Harold M.**

**Objective:** There is a considerable interest in high protein (HP) diets as a means of weight loss. However, effects of different types of protein on kidney health are unknown. Since obesity itself increases the risk of developing kidney disease, the objective of the study is to evaluate the effect of protein source in a high protein diets on kidney health and function in an obese rat model.

**Methods:** Male obese Zucker rats were given HP diets containing protein sources as casein (HPC), soy (HPS), and a mixture of soy, egg white, milk protein and wheat gluten (HPM) and were compared to obese (NPC) and lean (NPCL) rats given normal protein (NP) diets with casein as protein source. Body weight, feed intake and blood pressure were measured during the study. After 13 weeks rats were terminated and tissues were collected.

**Results:** HPS and HPM rats had higher body weights compared to NPC rats. Mean arterial pressure was lower in HPS in weeks 3 and 7, but similar to other groups by week 13. Proteinuria was higher in obese rats but protein source had no effect. Only HPM rats had higher kidney mass and serum creatinine compared to NPCL rats, higher total fat deposits and glomerular volume compared to obese groups, and higher glomerular damage as compared to NPC rats, but lower fibrosis compared to obese groups.

**Conclusion:** Protein at 35% energy from diet has minimal effect on the kidney structure and function with casein as protein source. Soy protein delayed the increase in blood pressure and a mixed protein source increased glomerular damage and serum creatinine but decreased interstitial fibrosis.

**Effects of Flaxseed Dosage on Plasma ALA and Total Enterolignan Levels in Healthy Adults**

**Edel, Andrea L.; Austria, J. Alejandro; Dibrov, Elena; Aliani-Michel and Pierce Grant N.**

Flaxseed is one of the richest sources of alpha-linolenic acid (ALA) and lignans and has gained attention due to its beneficial cardioprotective properties. As a result, there has been increased commercialization of foods enriched with flaxseed in market places. The aim of this study was to understand the effects of milled
flaxseed dosage on plasma bioavailability of ALA and lignan metabolites, called enterolignans (specifically enterodiol (END) and enterolactone (ENL)), in a healthy human population. Subjects 18-49 years of age were asked to consume one muffin daily containing either 10, 20, 30 or 40 g of ground flaxseed for 4-weeks (n=10/group). Fasted plasma samples were collected at baseline and 4-weeks and were analyzed for ALA and enterolignan content using gas chromatographic techniques. After 1-month, all groups had significantly elevated plasma ALA and total enterolignan levels (END + ENL) relative to baseline. There were no significant differences between the groups at 4-weeks. ALA and total enterolignan correlations were positive for each group, with 40g being the highest (R=0.81). Subjects tolerated 30g of flaxseed better than all other groups as assessed by reported side effects. In conclusion, consumption of 10-40g milled flaxseed daily for 1-month is an effective means to increase plasma bioavailability of the potentially cardioprotective ALA and enterolignan compounds. Additionally, plasma ALA and total enterolignan levels may be potential biomarkers of nutritional compliancy in flaxseed intervention trials where either low or high doses of flaxseed are required. Supported by CIHR, Flax2015, St. Boniface Hospital and Research Foundation, MMSF and ARDI.

Dietary flaxseed oil reduces levels of inflammatory adipokines and T-cell infiltration in adipose tissue of obese Zucker rats
Enns, Jennifer; Zahradka, Peter; Taylor, Carla

BACKGROUND In obesity, adipose tissue undergoes detrimental changes due to increased fat storage. Adipocytes become enlarged and dysfunctional, expressing an altered, pro-inflammatory adipokine profile. Immune cell infiltration into the tissue contributes to the metabolic complications of obesity, with local and systemic consequences for the inflammatory status of the obese individual. Dietary interventions with omega-3 fatty acids from marine sources have been successful at reducing inflammation.

OBJECTIVE The aim of this study was to determine whether flaxseed oil, a plant-based source of the omega-3 fatty acid α-linolenic acid (ALA), could also modulate inflammation and adipocyte dysfunction.

METHODS The Zucker rat is a well-characterized model of obesity and insulin resistance. Seventeen-week old male fa/fa Zucker rats with established obesity were fed either a control diet (faCTL) or a flaxseed oil supplemented diet (faFLAX) for 8 weeks. Lean Zucker rats were also fed the control diet (lnCTL). Adipose tissue was collected and analyzed for monocyte chemoattractant protein-1 (MCP-1) and TNF-α levels by immunoblotting. Macrophage and T-cell infiltration in adipose tissue was assessed by immunohistochemistry.

RESULTS FaCTL rats had elevated MCP-1 and TNF-α levels (5-fold and 10-fold, respectively) compared to lnCTL rats, but these adipokines were reduced to lnCTL levels with dietary flaxseed oil supplementation. Macrophage infiltration was not different among groups; however, faFLAX rats had 50% less T-cell infiltration than faCTL rats.
CONCLUSIONS Dietary intervention with ALA-rich flaxseed oil reduced protein levels of inflammatory markers MCP-1 and TNF-α in obese Zucker rats, and prevented T-cell infiltration in adipose tissue. The results suggest that, due to its ability to reduce inflammation in adipose tissue, ALA-rich flaxseed oil confers health benefits in obesity.

**In vitro digestibility of commercial cheeses with different texture**

Fang, Xixi; Rioux, Laurie-Eve; Labrie, Steve; Turgeon, Sylvie

The texture of solid food may influence food disintegration and food digestion. The digestion process affects significantly the bioavailability of bioactive peptides contained in dairy proteins. This study aimed to investigate the role of cheese texture on the digestion of cheese proteins, for human benefits.

Five commercial cheeses with different textures have been selected and characterised by physiochemical and textural analysis. Cheeses were cut into pieces with a particle size distribution similar to one obtained after oral mastication in human. Samples were submitted to an *in vitro* digestion model. Protein digestion was characterised like cheese disintegration, protein dissolution and protein degradation. Results showed that gastric digestion was the critical step in the digestion of cheese proteins. No significant difference of protein digestion among cheeses was found during duodenal digestion. The cheese disintegration during gastric digestion was faster for cheeses with a lower cohesive force. Cheeses which were easier to disintegrate showed a quicker dissolution and degradation of protein.

Comparison of cheese digestion with experiments performed without enzyme addition revealed that the cheese disintegration and the protein dissolution were due to both physicochemical effects (dilution, acidic conditions, mixing force etc) and enzymatic hydrolysis during digestion. More elastic cheeses (mozzarella) were longer to disintegrate than ripened and softer cheeses (camembert, aged cheese) to disintegrate. Disintegration is the first step necessary to facilitate enzyme accessibility to the substrate. The adjustment of cheese processing parameters, resulting in structural and textural changes of cheese, can be used to modulate the digestion of cheese proteins.

An Observational Study of Vitamin D Status of Students at Laval University Across the seasons

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**Background.** Vitamin D deficiency is endemic worldwide. It is essential for bone health, but recent literature suggests many other potential nonskeletal benefits. Concentrations of vitamin D are influenced by several factors (skin pigmentation, fat, age, sun exposure, diet, season, geographical location). This observational study assesses seasonal variation of vitamin D status and explores factors predicting vitamin D status among students from Laval University.

**Methods.** Serum 25(OH)D
concentrations, and factors that may influence vitamin D status were measured at 3 different time periods (fall 2010, end of winter and end of summer 2011) in a convenience sample of students. **Results.** The study sample included 65 subjects aged between 20-50 years old; 55.38% were Caucasian. Vitamin D status varied considerably according to seasons, with lower concentrations in winter and higher concentrations in summer (58.6 ± 20.7 nmol/l in the fall, to 50.9 ± 17.6 nmol/l in winter and 69.7 ± 24.7 nmol/l in summer). Black subjects showed lower vitamin D concentrations than those of Caucasian. During fall, 44.8% of black subjects showed an optimal vitamin D status (> 50 nmol/L) compared with 88.9% for Caucasians. During winter, 24.1% of black subjects had an optimal status compared with 66.7% of Caucasians. Finally, during summer, 100% of Caucasians exceeded the optimal level compared with 62.1% of black subjects. Serum concentrations of vitamin D were significantly associated with race, seasons and BMI (p <0.05) **Conclusion.** The low vitamin D status of students, particularly those of African immigrant students in Quebec raises an important public health problem.

**Dietary intake of participants with peripheral artery disease**

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Peripheral artery disease (PAD) is one of the most common cardiovascular diseases characterized by atherosclerosis of the arteries supplying blood to the arms and legs, thus resulting in impaired circulation. PAD affects about 800,000 Canadians and is particularly prevalent in older adults. Given the high prevalence of PAD, coupled with the known benefits of a healthy diet on the vasculature, data regarding the dietary patterns of Canadian individuals with PAD is required. A total of 30 participants with established PAD (ankle brachial index <0.9; mean age =72.1 ± 1.2 yrs; mean weight = 81.3 ± 2.4 kg; BMI = 28.0 ± 0.7) were recruited into this study from a vascular clinic. Dietary intakes were estimated using a 3 day food record and proprietary software complete with recent Canadian Nutrient File databases. Data collected were subjected to statistical analysis using SAS. The determined mean dietary macronutrient distribution (% of dietary energy) consisted of 18% protein, 32% fat, and 50% carbohydrate. The mean intakes ± SD using 3-DFR and FFQ respectively were: fat = 80.53 ± 43.54, 73.4 ± 21.8g; saturated fat = 24.18 ± 15.56, 22.8 ± 6.8 g; monounsaturates = 29.90 ± 17.23, 29.1 ± 9.8 g; polyunsaturates = 15.44 ± 7.72, 14.6 ± 5.5 g; sodium = 4156.58 ± 1441.4, 2852.28 ± 623.6 mg; alpha-linolenic acid = 1568 ± 823, 1590 ± 620 mg; eicosapentaenoic acid =90 ± 152, 50 ± 60 mg; docosapentaenoic acid =18.6 ± 16.7 mg (3-DFR); docosahexaenoic acid = 128.5 ± 140.6, 110 ± 79 mg and total omega-3 = 1877.1 ± 908.5 mg (3-DFR). When compared to national guidelines, the participants consumed a diet that was 60% and 319% higher than recommended for saturated fat and sodium, respectively. Hence, PAD subjects should be encouraged to eat diet that is lower in saturated fat
Antioxidant and antihypertensive properties of Reverse-Phase HPLC purified hempseed (Cannabis sativa L) protein-derived peptides. 
Girgih, Abraham T. and Aluko, Rotimi E.

In this study, the *in vitro* antioxidant and antihypertensive properties of Reverse-Phase HPLC purified hemp seed peptides were investigated. The purified peptides exhibited better antioxidant properties compared to the HPH by scavenging 2,2-diphenyl-1-picrylhydrazyl (DPPH), superoxide and hydroxyl radicals. Scavenging abilities of the fractionated peptides increased with hydrophobicity except for the hydroxyl radical which showed a decrease or no activity. Glutathione (GSH) had stronger scavenging activity (62-68%) than the purified fractions (10-58%) against DPPH and hydroxyl radicals but a weak scavenger of superoxide radical. GSH (20%), HPH (9%) and its HPLC fractions (5-12%) possessed mild reducing abilities of metal ions but exhibited strong metal chelation activities which ranged from 59-78%. HPH had similar chelating properties as its HPLC fractions. GSH, HPH and purified peptide fractions significantly (*p*<0.05) inhibited linoleic acid oxidation in comparison to the control. Fractionation resulted in peptides with stronger ACE and renin inhibitory activities (83-97% & 18-60% respectively) compared to the HPH (71% & 51% respectively), indicating that purification improved potency. These results show that purification could improve HPH peptide scavenging of radicals, reduction and chelation of metal ions activities as well as inhibit enzymes responsible for elevation of blood pressure. Thus, HPH and its HPLC fractions may serve as potential ingredients for the development of therapeutic products to use as antioxidants and antihypertensive agents.

Fatty acid profile and sensory characteristics of table eggs from laying hens fed different ratios of saturated fat to linoleic and oleic acid 
Goldberg, E.; Ryland, D.; Gibson, R.; Aliani, M.; House, J.D.

The current study was designed to assess the fatty acid composition and sensory attributes of eggs procured from hens consuming diets containing different ratios of saturated fat (SF) to linoleic (LA) and oleic acid (OA). Forty-eight individually caged Shaver White hens received 1 of 6 isonitrogenous and isoenergetic diets for a period of 7 weeks. Diets were arranged in a 2 x 3 factorial design, containing either 1.5% or 3.0% alpha-linolenic acid (ALA), and either a low (0.5), medium (1.0) or high (2.0) ratio of SF:LA+OA. Yolk content of palmitic and stearic acids were unaffected (*p*>0.05) by dietary treatment. Yolk content of docosahexanoic acid (DHA) was significantly increased by the ratio, but remained unaffected the level of dietary...
ALA. Only gamma-linolenic acid and ALA were affected by dietary ALA, and not by the ratio. As the SF:LA+OA ratio increased, yolk content of lauric, myristic, palmitoleic, eicosapentaneoic acid (EPA), docosapentaneoic acid (DPA), DHA, total omega-3 polyunsaturated fatty acids (PUFA) and total medium-chain triglycerides (MCT) significantly increased, while LA, arachidonic acid (AA) and total omega-6 PUFAs decreased. Additionally, there was a significant interaction (P=0.039) between the ratio and ALA for palmitoleic acid. Trained panelists (n=8) evaluated 4 aroma and flavour attributes ('egg', 'creamy', 'buttery' and 'sweet') of cooked egg product. No significant differences (P>0.05) in aroma and flavour attributes were found between eggs from different dietary treatments. The results provide evidence that increasing the ratio of SF:LA+OA in the layer diet will positively affect the fatty acid profile of eggs without having adverse sensory effects.

**Antioxidant Properties of Alkaline Extracts from Whole-Grain Cereals derived Insoluble and Soluble Dietary Fibre**

**Guo Weiwei** and Beta Trust

The inverse correlation between the intake of dietary fibre (DF) and the risk of cardiovascular disease and cancer has been established. However, the reported health benefits of DF are mostly linked with its physiological effects. It is known that phenolic acids are largely bound to fibre components in cereal cell walls. Therefore, the investigation of cereal DF-linked phenolic acids and their antioxidant properties is important to support the health claim of DF consumption.

The extraction yields of IDF and SDF from seven whole-grain cereals ranged from 11.73% to 23.71% and 2.28% to 5.15%, respectively. IDF alkaline extracts showed significantly (p<0.05) higher total phenolic content (TPC) (397-1835 mg ferulic acid equivalent/100 g) and antioxidant activity (AOA) (667-1872 µmol trolox equivalent/100 g) than WG and SDF extracts for the same sample. Corn IDF extracts exhibited the highest TPC and DPPH radical scavenging activity, followed by red rice IDF extracts. Eight monomeric phenolic acids (PA) and three diferulic acids (diFA) were identified and quantified by reversed phase high performance liquid chromatography coupled with quadrupole - time of flight mass spectrometry. Ferulic acid and 8-o-4’ diFA were the predominant form of monomeric PA and diFA, respectively. FHS 74 Int and Caco 2 BBE cell lines were employed as models to reveal the effect of IDF released phenolic acids on human gut health. Preliminary results show the cytoprotective activity of corn IDF and WG extracts against 2,2’-azobis(2-amidinopropane) dihydrochloride (AAPH) and xanthine oxidase induced oxidation in cells as evaluated by MTT cell viability assay.
The effect of pulse-containing diets on hypertension and associated vascular remodeling in the spontaneously hypertensive rat.
Hanson, Matthew; Zahradka, Peter; Taylor, Carla

Background Pulse crops and their bioactive compounds have been shown to affect cellular remodeling that is associated with hypertension and arterial stiffness in vitro. This experiment was carried out to test the effect of 30%w/w pulse-containing diets on blood pressure and associated remodeling events including pulse wave velocity (PWV), and left ventricle weight to body weight (LVW/BW) in SHR, a model of human essential hypertension with known arterial stiffness.

Methods/Results The SHR were assigned to one of 6 diet groups: SHR bean (SHRb), pea (SHRp), lentil (SHRl), chickpea (SHRc), mixed pulse (SHRm), pulse-free control (SHRctrl). Normotensive WKY rats were also fed the control diet. There were no significant differences in body weight, adiposity, or LVW/BW between the SHR groups over the 4 week study period, however, the WKY differed significantly in all categories (p<0.0001). There were no significant differences between the SHR groups with respect to weekly PWV as measured by Doppler ultrasound, however, the PWV of the WKY group was significantly lower when compared to the SHR groups. There were significant differences in blood pressure between WKY and SHR groups both at week 0 and week 4 (p<0.0001). The rise in blood pressure over 4 weeks was significantly attenuated in the SHRl group compared to the SHRctrl group (+8.28 and +30.54mmHg, respectively; p=0.019).

Conclusion The lentil-containing pulse diet was able to significantly attenuate the rise in blood pressure when compared to the SHRctrl, without a corresponding change in pulse wave velocity, body weight, LVW/BW, or adiposity.

EFFECT OF THE ENDOGENOUSLY DERIVED CANOLA DERIVED ANTIOXIDANTS IN LIPID OXIDATION OF CANOLA OIL-IN-WATER EMULSIONS
Huidrom, Dayanidhi; Thiyam, Usha and Scalon, Martin

Lipid oxidation is one of the detrimental factors in affecting the quality of food. Various attempts have been made to retard lipid oxidation; physical as well as chemical means. One of the most effective ways is the use of antioxidants. Most active antioxidants used in industries are mostly synthetic and, thus, raise its health concern. Therefore, natural and healthy antioxidants that effectively control oxidation are now on search. Lipid in food mostly exists in the forms of emulsion. Emulsions are thermodynamically unstable mixture which is formed when two (or more) immiscible liquids are dispersed over each other. Surface active agents called emulsifiers are generally used to reduce surface tension to keep it kinetically stable for certain amount of time. The present project aims at evaluating the effect of canola (Brassica juncea) derived antioxidants on the oxidation in whey protein stabilized canola oil-in-water emulsion at elevated temperature. 10 % canola oil in water emulsion using 1% whey protein as emulsifier was first prepared by passing through homegeniser. Antioxidants; sinapic acid extract (SA(E)), sinapine (SP), Canolol (CAN) and whole extract, (WE) at two concentrations (100 and 350 µM), were added and incubated at 30°C. Sinapic acid (SA) and Butylated hydroxyl toluene
BHT standards were also used as references. Primary oxidation marker like peroxide and secondary oxidation volatile products like hexanal, pentanal and 2,4-heptadienal were monitored to assess the anti-oxidative effect. BHT was found to be the most effective antioxidants. WE and SP were also equally good as BHT. Peroxide values were significantly different (P<0.05) in case of BHT-100*, BHT-350, SP-350 and WE-350 compared to control. The same pattern was also followed in volatiles measurement. WE and SP were earlier shown to be power anti-oxidants as shown by DPPH, Chelating and Reducing assays. This also indicated that WE and SP have the potential to replace other synthetic AO though not as powerful as them. The physical stability of the emulsion was determined by particle size measurement. The particle size (diameter) of oil droplets remains constant throughout experimental period (0.162-0.188 μm). Viscosity was also determined by rheometer and found to be to be stable over 15 days time (126.51 – 136.43 mPaS). Natural and low cost yet effective antioxidants are always on search by the food industries. Moreover, consumers are also concerned about the consumption of synthetic additives in foods. Therefore, This study has wider implication from the food industry and consumer perspective.

Differential Effects of Dietary Fish Oil and Soy Protein on Renal Disease and Eicosanoids in Cystic Kidney Disease (CKD)

Ibrahim, Naser; Jia, Yong; Devassy, Jessay; Gauthier, Joy; Yamaguchi, Tamio and Aukema, Harold

Renal prostanoids are elevated in renal disease and pharmacological inhibition of prostanoids can slow disease progression. Since dietary fish oil (FO) and soy protein (SP) also slow disease progression in several models of chronic renal disease and can alter renal eicosanoid production, the effects of these dietary interventions on renal disease and eicosanoid formation were determined.

Weanling normal (+/+) and diseased (cy/+)) Han:SPRD-cy littermates were given AIN- 93G based diets containing either casein protein (CP) or SP, and soy oil (SO) or FO in a 3-way design for 8 weeks. SP reduced renal cyst growth and fibrosis in both cortex and medulla, while FO reduced fibrosis only in the medulla of diseased rats. Both SP and FO reduced serum cystatin c and creatinine in diseased rats with the effect of SP being stronger. Renal eicosanoids, measured by LC/MS/MS, were altered primarily in the diseased compared to normal cortex, with renal prostanoids being increased and hydroxy fatty acids (OHFAs) being generally decreased. SP reduced prostaglandin E2 (PGE2) and metabolites of prostacyclin and thromboxane A2 in the diseased cortex in parallel with its protective effects on disease. 5-hydroxyeicosatetraenoic acid (5-HETE), and 13-hydroxyoctadecadienoic acid (13-HODE) were reduced in diseased kidneys and SP increased their levels in the cortex. On the other hand, FO reduced all prostanoids, most OHFAs, and increased formation of 3-series prostanoids, with effects being observed in both normal and diseased cortex and medulla.

Hence, FO effects on renal eicosanoids did not parallel effects on disease, which were observed only in the medulla. On the other hand, SP opposed the effects of disease on renal cortical prostanoids, 5-HETE and 13-HODE levels in this CKD
model. SP may mediate its renoprotective effects via blunting of these disease induced alterations.

Omega-3 supplementation and inflammatory gene expression in the small intestine of patients with type 2 diabetes
Labonté, Marie-Ève; Couture, Patrick; Tremblay, André J.; Hogue, Jean-Charles; Lemelin, Valéry; Lamarche, Benoît

The extent to which long-chain omega-3 polyunsaturated fatty acids (LCn-3PUFA) from fish oil, such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), exert their anti-inflammatory effects by down-regulating intestinal inflammation in human is unknown. **Objective:** To investigate the impact of EPA+DHA supplementation on the expression of inflammatory genes in the small intestine of patients with type 2 diabetes. **Methods:** A total of 12 men with type 2 diabetes were recruited in this placebo-controlled randomized crossover study. After a 4-week run-in period, patients received in random sequence 5 g/d of fish oil providing 3 g of EPA+DHA or placebo (corn and soybean oil) for 8 weeks, each separated by a 12-week washout period. Gene expression was assessed by real-time PCR in duodenal biopsy samples obtained in the fasted state at the end of each treatment phase. **Results:** Intestinal mRNA expression levels for interleukin(IL)-6 and tumor-necrosis factor(TNF)-α were hardly detectable after either treatment (<100 copies/10^5 copies of the reference gene ATP5o). Intestinal mRNA expression of IL-18 and of the transcription factor STAT3 was higher (>5000 copies/10^5 copies ATP5o) but still relatively low and EPA+DHA supplementation had no impact on any of these levels (P≥0.73 between treatments). Plasma C-reactive protein (CRP) concentrations after supplementation with EPA+DHA (5.2 ± 4.5 mg/L) were not significantly different than values measured after placebo (8.0 ± 10.8 mg/L, P=0.2). **Conclusion:** These data suggest that gene expression of pro-inflammatory cytokines and STAT3 in duodenal cells is low in patients with type 2 diabetes and not affected by EPA+DHA supplementation.

Eicosapentaenoic acid and docosahexaenoic acid in Alzheimer's disease
Lebbadi, Meryem; Tremblay, Cyntia; Fortin, Samuel and Calon, Frédéric

Dietary supplementation with n-3 polyunsaturated fatty acids (n-3 PUFA) reduces amyloid-beta (Aβ), tau pathology and improves cognitive performance in animal models of Alzheimer disease (AD). However, Analyses of brain phospholipid fatty acid profiles reveal a selective deficiency and enrichment in eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), respectively. In order to account for this difference in brain fatty acid levels, 3xTg-AD mice modeling AD neuropathology, were fed with 3 diets: no DHA, high DHA or high EPA, to investigate if EPA could have a neuroprotective effect similar to or higher than the DHA. As expected, high
DHA diet shifted upward the brain DHA level but more in wild-type mice (+93%, P<0.001). High EPA diet, as planned, increased EPA level in the brain of mice especially in 3xTg-AD mice (+130%, P<0.001). However, No DHA diet increased arachidonic acid (AA) level especially in the brain of 3xTg-AD mice (+106%, P<0.001). High DHA and high EPA diets decreased the level of insoluble Aβ42/ Aβ40 ratio (-35% and -59%, P<0.01; respectively) in the brain of 3xTg-Ad mice. 3xTg-AD mice that were fed with high DHA and high EPA diets, exhibited lower cortical levels of soluble phosphorylated tau compared to wild-type mice (-34% and -33%, P<0.05; respectively). In conclusion, high DHA and high EPA diets increased brain DHA and EPA and decreased AA level in 3xTg-AD mice. Moreover, high DHA and high EPA diets, in a same manner, induced biomarker changes consistent with a beneficial effect against AD-like neuropathology.

CHANGES IN DIETARY VARIABLES IN MEN AND WOMEN IN RESPONSE TO A 12-WEEK NUTRITIONAL INTERVENTION PROMOTING THE MEDITERRANEAN DIET AND BASED ON THE SELF-DETERMINATION THEORY
Leblanc V., Hudon AM, Royer MM, Corneau L, Dodin S and Lemieux S

Objectives: The aim of our study was to determine gender differences in changes in adherence to the Mediterranean diet and in self-determined motivation, in response to a 12-week nutritional intervention promoting the Mediterranean diet. Methods: The intervention was based on the Self-Determination Theory and used a motivational interviewing approach. It included 3 group and 7 individual sessions. A Mediterranean score was calculated with a validated food frequency questionnaire. Motivation was evaluated with the Regulation of Eating Behaviors Scale. Forty-one men (40.4±7.5 y; 30.8±4.0 kg/m²) and 43 premenopausal women (41.9±6.9 y; 29.3±5.8 kg/m²) were included in this preliminary analysis. Results: Mediterranean score increased (time effect, p<0.0001) and body weight decreased (time effect, p=0.0002) in response to the 12-week nutritional intervention in men and women, but without significant gender by time interaction. The global score of self-determined motivation significantly increased, with increases in scores of intrinsic motivation and integrated regulation of motivation (time effect, p≤0.0001), with a similar response in men and women. Although there was a trend for an association between changes in self-determined motivation score and changes in the Mediterranean score in men (r=0.30 ; p=0.07), no such association was observed in women. Conclusions: Preliminary results suggest that the nutritional intervention based on the Self-Determination Theory allowed positive changes in self-regulation motivation, which possibly contributed to improvements in dietary intakes and lowering of body weight. However, gender differences in the pattern of associations between motivational variables and dietary changes warrant to be further investigated.

Effects of Saskatoon berries on male reproductive function in a rat model of renocardiac syndrome
**Background and Objectives:** Black raspberries (Rubus coreanus) are well accepted in Asian countries as medicinal herbs or tonics for decreasing fatigue. The black raspberry extract have shown to increase testes weight, sperm counts, sperm motility, testosterone and reduced exercise induced fatigue. Whether Saskatoon berries grown in Manitoba have similar effects have not been tested. This study was planned to test potential effects of Saskatoons on male reproductive health. Since individuals with heart and kidney ailments frequently suffer from fatigue and reproductive problems, a rat model of renocardiac syndrome was chosen. **Methods:** Weanling male normal and Han:SPRD-cy rats were assigned to two AIN 93G based diets containing either saskatoon berry powder (10%, w/w) or control diet. After 8 weeks of feeding, reproductive and accessory organ weights, cauda epididymal sperm concentration and sperm morphology were analyzed. Seminolipids and lipid peroxidation were measured in both testis and sperm. **Results:** Body weight, testis and epididymis weight were not affected by the diets or disease conditions. The renocardiac syndrome rats had significantly more abnormal spermatozoa than the normal rats, mostly in tail abnormality. The berry diet decreased the sperm concentration in both normal (22%) and diseased rats (29%). The lipid peroxides in both sperm and testis were lower in diseased animals than the normal counterpart. The seminolipid content was not affected by the diets and the disease conditions. **Conclusions:** Overall male reproductive function can be influenced by the renocardiac disease states and Saskatoon berry intake. The decrease of sperm concentration with no changes in spermatogenic seminolipids by Saskatoon berry require a further study to find what stages of spermatogenesis are affected by the berry intake.

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**Treatment with low-dose resveratrol everses cardiac impairment in obese prone but not in obese resistant rats**

**Objectives:** Treatment with resveratrol will reverse cardiovascular abnormalities in high fat (HF) diet fed rats. Resveratrol will also improve metabolic parameters in obese prone (OP) and obese resistant (OR) rats.

**Methods:** OP and OR were fed a HF diet for 17 weeks; Sprague Dawley (SD) rats fed laboratory chow served as control animals. OP, OR and SD rats were randomized into treated and non treated groups. During the last 5 weeks of study, resveratrol
(daily by oral gavage at a dosage of 2.5 mg/kg body weight) was administered to treated group. Cardiac structure and function, blood pressure, adiposity, glucose, insulin, lipidemia, inflammatory and oxidative stress markers were assessed.

**Results:** OP rats had significantly higher body weight and adiposity when compared to OR rats; treatment had no effects on these parameters. HF fed OP and OR rats had prolonged isovolumic relaxation time (IVRt). Treatment with resveratrol significantly decreased IVRt in OP but not in OR rats. Fasting serum glucose and insulin were elevated in OP rats whereas OR rats had increased serum glucose and normal insulin concentrations. Treatment reduced serum glucose, while insulin levels were increased in both OP and OR rats. OP rats had increased inflammatory and oxidative stress markers, serum triglycerides and low density lipoprotein, which were significantly reduced with treatment.

**Conclusions:** Treatment reversed abnormalities in diastolic heart function associated with HF feeding in OP rats, but not in OR rats. The beneficial effects of resveratrol may be mediated through improvements in metabolic parameters.

**Lathosterol to cholesterol ratio, a surrogate marker of cholesterol synthesis, predicts non-response to cholesterol lowering from plant sterol supplementation.**

MacKay, D.S; Jones, P.J.H.

**Background:** Plant sterols (PS) are steroid compounds similar to cholesterol which occur naturally in plants and vary only in side chains on the C24 carbon. Consumption of plant sterols has been shown to reduce circulating low density lipoprotein-cholesterol (LDL-C) in the ~10% range with recommended supplemental doses of 2-3g/d. The responsiveness of LDL-C to PS supplementation can vary widely across individuals.

**Objectives:** It has been hypothesized that elevated cholesterol synthesis may reduce PS-associated LDL-C lowering based on post-hoc associations. The objective was to examine if PS-associated LDL-C lowering can be predicted by serum lathosterol to cholesterol ratio (LCR), a marker of cholesterol synthesis.

**Methods:** A two phase (28 d each), single-blind, randomized, placebo controlled crossover trial was conducted comparing the PS-associated LDL-C lowering of 15 high synthesis (HS, mean LCR =3.55; 95% CI 3.13, 3.98) vs. 27 low synthesis (LS, mean LCR = 1.49; 95% CI 1.33, 1.63) participants. Screening criteria for all participants were: age 30-75, fasting LDL-C values >2.85 and <6.5 mmol/L, fasting triglycerides (TRIG) <4.51mmol/L, fasting glucose values <6.1 mmol/L, no history of acute or chronic disease, non-smoking, and no recent history lipid lowering medication or dietary supplements.

**Results:** HS participants had significantly (p=0.029) reduced PS-associated LDL-C lowering (EMMEAN= -.015 mmol/L; 95% CI -.18, .15) compared to LS participants (EMMEAN= -.249 mmol/L; 95% CI -.37, -.12).

**Conclusion:** A priori cholesterol synthesis status as measured by LCR is associated with the extent of PS-associated LDL-C lowering. High cholesterol synthesizers may be non-responders to PS therapy.
Impact of probiotic intake on stability of fecal microbiota in healthy subjects
Matamoros, Sébastien; Filteau, Marie; Savard, Patricia and Roy, Denis

Probiotic consumption is known to influence the composition of the intestinal gut microbiota, by significantly increasing the counts of the target probiotic strains and reducing the numbers of potentially pathogens such as Enterococcus sp. However it is still unknown whether other components of the fecal microbiota are affected. Few studies have been conducted far to measure the impact of probiotic intake on the homeostasis of the gut microbiota of healthy subjects. This could be of critical importance for the evaluation of probiotic health claims.

DNA from fecal samples of 51 healthy volunteers was obtained during a previous randomized, parallel, placebo-controlled trial (NCT00730626) before and after four weeks of commercial probiotic yogurt consumption. The fecal microbiota structure of these samples was assessed by culture-independent methods. The yogurts fermented with Lactobacillus delbrueckii subsp. bulgaricus and Streptococcus thermophilus were supplemented with $10^9$ (BAL) or $10^{10}$ cfu/100g (BAL-10) Bifidobacterium animalis subsp. lactis (BB-12) and $10^9$ Lactobacillus acidophilus (LA-5) as well as 40 mg green tea extract. Statistical analysis of terminal restriction fragment length polymorphism (T-RFLP) results showed no difference in profile variation between placebo or yogurt consumption (Bray-curtis distance) but a significant increase in diversity was observed in the BAL-10 group (mean difference $0.14 \pm 0.046$, p=0.009). PCR quantification (qPCR) of dominant fecal populations and subdominant Bifidobacterium species revealed that beyond the increase in probiotic species, the variations observed were largely due to inter-subject variation rather than treatment effect.

In conclusion, the global fecal microbiota structure of healthy adults is not disturbed by the probiotic yogurt consumption. Additionally, an increased dose of BB-12 could help improve gut microbiota diversity.

Development of a rodent model of moderate vitamin B6 deficiency
Mayengbam, Shyamchand; Raposo, Sara and House, James D.

Overt vitamin B6 deficiency in the population of developed countries is rare. However, increasing evidence supports the potential link between moderate B6 deficiency and adverse health outcomes. The objective of the study was to develop a rat model of moderate B6 deficiency for future studies designed to examine the link between nutrition and disease outcomes. Male weanling rats (n=4/treatment) received a semi-purified AIN-93G diet containing either 0.07 (severely deficient; SD), 0.7 (moderately deficient; MD), or 7 mg/ kg diet pyridoxine-HCl (control; C) for 5 weeks (ad libitum basis). Plasma pyridoxal 5’-phosphate (PLP) and homocysteine (Hcy) were determined by HPLC using pre-column derivatization methods. A 24 hr
urine sample, collected via metabolic cage, was analyzed for 4-pyridoxic acid (PA) content, a metabolite of PLP. After 5 weeks, the rats consuming SD had significant lower body weights (p<0.001) and total feed intake (p<0.005), however, there was no significant difference between MD and C rats. Plasma PLP content was below the limits of quantitation in SD rats and it was significantly lower (P<0.05) in MD rats (38.42±1.43 nM) compared to C rats (598.02±126.88 nM). Urinary PA was detectable in C rats (465±20.98 nM/24 hr) only. Plasma Hcy was significantly higher (p≤0.001) in SD rats (38.24±5.54 µM) compared to MD (7.64±0.38 µM) and C rats (8.93±0.65 µM). Regression of plasma Hcy and dietary B6 content provided evidence that a moderate vitamin B6 deficiency (low plasma PLP with no increase in Hcy) was evident in rats consuming diets with 0.3-0.7 mg/kg diet of pyridoxine-HCl.

**Can carrot powder improve visual function in diabetic retinopathy?**

**McClinton, Kathleen RD; Sauvé, Yves PhD; Aliani, Michel PhD; Kuny, Sharee; Suh, Miyoung PhD, RD.**

**Objectives:** While carotenoids are essential for vision, their potential role in diabetic retinopathy has yet to be elucidated. By providing whole carrot in the diet, this study examined carotenoid metabolism and visual function in type 1 diabetes.

**Methods:** Weanling male Wistar rats (n=62) were assigned to two groups, either with or without carrot enriched (15%, w/w) diet, reflecting Canadian Diabetes Association recommendations. After 3 weeks, type 1 diabetes was induced in half of each diet group with streptozotocin injection and animals were fed for a further 9 weeks. Groups were: normal control (N); normal carrot enriched (NC); diabetic control (D); and diabetic carrot enriched (DC). Retinal function and anatomical integrity were assessed with electroretinogram (ERG) and immunohistofluorescence. Vitamin A and carotenoid levels were assessed in the serum, liver, and retina by ultra performance liquid chromatography.

**Results:** Loss of ERG oscillatory potentials, a typical phenomenon in diabetes, with normal histology indicated early stage diabetic retinopathy. Animals fed carrot diet showed significantly higher ERG amplitudes (rod and cone photoreceptors), reflecting higher phototransduction, in controls but not in diabetes. Diabetic animals fed carrot had highest carotenoids and retinol liver reserves, suggesting disturbance of retinol clearance in these organs during diabetes.

**Conclusions:** This is the first study using whole carrot intervention for visual function. Under healthy conditions, carrot consumption is beneficial to vision, and might reflect a higher availability of vitamin A chromophore involved in sight. In diabetes, the opposite may be true due to the accumulation. Finding the underlying mechanism warrants further study.
Several randomized clinical trials (RCTs) suggest a beneficial effect of chocolate rich in flavanols endothelial function (FMD) and on blood pressure (BP). No RCTs have evaluated these effects in pregnant women. The objective of this 2-group parallel, double blind RTC was to examine the effects of high polyphenols chocolate on the FMD and BP of normotensive pregnant women. Forty-four healthy pregnant women among the 176 screened were randomized to the high flavanol chocolate group (n=23) or placebo (n=21) for 12 weeks. At randomization, 60, 120 and 180 minutes after the single dose of 40 g of chocolate and 6 and 12 weeks after the daily intake of 20g of chocolate, serum concentrations of flavanols and theobromine, flow-mediated dilatation and blood pressure and, were evaluated. Compared with placebo, after 180 minutes and 12 weeks, consumption of 40 g of chocolate rich in flavanols was accompanied by a significant increase in serum epicatechin (p<0.001). Theobromine concentrations were significantly higher 180 minutes and 12 weeks after consumption of chocolate experimental and placebo (p<0.001). FMD was not different between the 2 groups for all the predefined time periods. A significant decrease in diastolic BP was observed 60 min after consumption of dark chocolate (-2.29 ± 3.95 mmHg, p=0.0108) between the 2 groups. No other significant changes within or between groups were observed. The results of this pilot RCT confirm the feasibility of large-scale RCT and raise some methodological physiological and clinical important elements to be taken into account.

Molecular mechanisms underlying conjugated linoleic acid-induced skeletal muscle glucose transport
Mohankumar, Suresh K.; Taylor, Carla G.; Siemens, Linda; Zahradka, Peter C.

Conjugated linoleic acid (CLA), a dietary lipid, has been proposed as an anti-diabetic/obesity agent. However, studies addressing the mechanisms of CLA on skeletal muscle glucose transport are limited. Our study investigated the cellular dynamics of cis-9, trans-11 (c9,t11) and trans-10, cis-12 (t10,c12) CLA isomers using L6 myotubes. Cells were treated without or with CLA isomers for 15 minutes and subsequently monitored for glucose uptake using isotope/fluorescently-labelled 2-deoxyglucose, intracellular Ca2+ (Cai2+) release using Fluo-4 AM and GLUT4 translocation using immunofluorescence as well as protein phosphorylation events using Western blotting. Acute exposure of myotubes to CLA stimulated GLUT4 trafficking and glucose uptake by activating insulin-dependent signals, including phosphatidylinositol 3-kinase (PI3-kinase) p85 subunit and Akt substrate-160 kDa (AS160). Intriguingly, t10,c12-CLA stimulated Cai2+ release and phosphorylation of Ca2+/calmodulin-dependent protein kinase II (CaMKII) and AMP-activated protein kinase (AMPK) in a concentration-dependent manner, whereas c9,t11-CLA showed modest or no effects. Blocking PI3-kinase, Cai2+ release, CaMKII and AMPK abrogated CLA isomer-mediated AS160 phosphorylation and glucose uptake. Genetic knock down of CaMKII in myotubes using siRNA completely abolished CLA isomer-mediated glucose uptake. Furthermore, the
evidence for a positive correlation between CaMKII and AMPK, in conjunction with inhibition of t10,c12-CLA-mediated AMPK activation by CaMKII blockers, indicates that CaMKII acts upstream of AMPK. These data establish that t10,c12-CLA acts via Cai2+-CaMKII-AMPK-AS160 to stimulate skeletal muscle glucose transport, whereas the mechanism of c9,t11-CLA remains unclear.

**Total Carotenoid and Ferulic Acid Content in Hand Dissected Fractions of Diverse Cereal Grain Varieties**

Ndolo, Victoria U. and Beta, Trust

Carotenoids and ferulic acid are among the grain phytochemical components that enhance human health due to their antioxidant properties. To investigate the potential of grain fractions as functional food ingredients, 10 cereal grain varieties were hand dissected into pericarp, aleurone layer, germ and endosperm. These fractions were analysed separately, following microwave-assisted extraction, for ferulic acid (FA) by using high performance liquid chromatography (HPLC) coupled with photodiode array detection (PAD). Carotenoids were extracted using water saturated butanol and total carotenoid content (TCC) quantified using spectrophotometer and expressed as lutein equivalence. Results showed that FA and TCC varied significantly (p<0.05) across the grains and within the grain fractions. FA content was low in the endosperm fraction of all the grains with slightly higher values (183 µg/g) in yellow corn compared to wheat (106µg/g). However, FA in pericarp fractions was remarkably higher in yellow corn (14,299-22,437µg/g), followed by wheat and regular barley (3,193 to 3,815µg/g) and lowest in purple barley (1,915 µg/g). A similar trend was observed in FA content in the aleurone layers. FA contents in yellow corn and regular wheat germ fractions were similar ranging from 825 to 1,054 µg/g. TCC in the endosperm was higher in yellow corn (14.2-31.4µg/g), followed by wheat (1.7-2.3µg/g) and lowest in barley (0.9-1.2µg/g). In germ fractions, TCC was highest in barley (12.7-14.8µg/g), followed by wheat (8.5-9.9µg/g) and lowest in corn (3.2-4.8µg/g). Variations in FA and TCC content in grain fractions complement each other, hence showing promise of utilising grain fractions as alternative healthy food ingredient.

**Effects of changes in pH and temperature on the inhibition of Salmonella and Listeria monocytogenes by allyl isothiocyanate**

Olaimat, Amin N.; Holley, Richard A.

This project examined the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) of mustard allyl isothiocyanate (AITC) against five strains each of *Salmonella* and *Listeria monocytogenes*, as well as the influence of different pH and temperature combinations on AITC *in vitro* inhibitory activity against these pathogens. MIC and MBC values were determined using Mueller-Hinton broth (MHB) containing different concentrations of AITC incubated
at 37ºC for 24h. The effect of temperature and pH on AITC activity was determined by exposing the separate pathogen mixtures in MHB buffered at pH values of 5.0, 7.0 and 9.0 to 200 ppm of AITC incubated at 4, 10 or 21ºC for 10d. The MIC and MBC values of AITC ranged from 60-100ppm and 120-180ppm, respectively, against the pathogens. AITC was not antimicrobial up to 10 days when low temperatures (4 or 10ºC) were used at alkaline pH, but at neutral pH AITC reduced *L. monocytogenes* by 4.1 and 8.5 log CFU/ml at 4 and 10ºC, respectively. At acidic pH, AITC was more effective against *Salmonella* which were reduced 2.6 and 6.2 log CFU/ml at 4 or 10ºC, respectively. However, AITC was most effective when 21ºC was used at neutral pH against *L. monocytogenes* (cells were not detected after 3d) and at 21ºC with pH 5.0 against *Salmonella* (cells were not detected after 6d). The results showed that mustard AITC can be a potent natural antimicrobial against foodborne pathogens when low or neutral pH values are combined with room or refrigerator temperature exposures.

**Pyridoxine Deficiency and Homocysteine: Effects on Liver Lipids**

Raposo, Sara

Severe vitamin B6 (B6) deficiency has been observed to increase liver lipids in rodents, especially when under high protein diets (Okada & Ochi, 1971; Suzuki & Okada, 1981). Severe B6 deficiency is rare, but moderate B6 deficiency is observed in diabetes, cardiovascular disease, people undergoing tuberculosis treatment, and hemodialysis (Ahn, Min, & Cho, 2011; Bush et al., 2010; Keith et al., 2009; Pellock, Howell, Kendig, & Baker, 1985). Moderate B6 deficiency may increase the development of non-alcoholic fatty liver disease (NAFLD), which could increase disease-related complications. NAFLD is the most common diagnosis of liver disease among Canadians, in which fat makes up 5%-10% of the organ (Aglukkaq, Health Canada). A pilot study was conducted with twelve Sprague Dawley rats to determine if moderate B6 deficiency correlates with altered lipid metabolism leading to hepatic lipid accumulation. Rats were randomized to one of three dietary groups, n=4, to receive 0.07, 0.7 and 7 mg/PN-HCl/kg amounts of B6 in the feed, representing severe and moderate B6 deficiency and adequate B6 status. Results indicated moderate and severe B6 deficiency increased hepatic lipids significantly compared to controls, but did not differ significantly between each other. Increased plasma homocysteine (HCY) had a very strong relationship with increased hepatic lipid size, which was only found to be significant in severely deficient group. Results show plasma HCY of 15.5 μmol/L and above correlated with significant increase in hepatic lipids and rising hepatic lipid droplet size. Investigation into HCY’s possible use as a biochemical marker of NAFLD progression is warranted.

**Impact of the Mediterranean diet on apolipoprotein A-I kinetic in men with metabolic syndrome**

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The objective of the study was to investigate the impact of the Mediterranean diet (MedDiet) on apolipoprotein (apo) A-I kinetic in men with metabolic syndrome (MetS). The diet of 26 men aged between 24 to 62 years with MetS (NCEP-ATP III) was first standardized to a North American control diet, which they consumed for 5 weeks. MedDiet was then consumed over a subsequent period of 5 weeks. Both predetermined diets were consumed under isoenergetic feeding conditions. During the last week of each diet, participants received a single bolus dose of [5,5,5-\textsuperscript{2}H\textsubscript{3}] L-leucine and fasting blood samples were collected at predetermined time points over a period of 96 hours. ApoA-I kinetic was determined by multicomartmental modeling. The plasma high-density lipoprotein-cholesterol (HDL-C) response to MedDiet was highly heterogeneous and as a result, no mean change in HDL-C was observed. On the other hand, plasma apoA-I concentrations and pool size were reduced significantly compared with the control diet (both \( P<0.05 \)). MedDiet tended to reduce apoA-I production rate (PR, \( P=0.07 \)), but had no impact on apoA-I fractional catabolic rate (FCR, \( P=0.64 \)). However, multiple regression analysis revealed that variations in apoA-I FCR (\( P=0.006 \)) and in plasma very-low-density lipoprotein-triglycerides (VLDL-TG, \( P=0.002 \)) concentrations were the only variables predicting the heterogeneous HDL-C response to the MedDiet. Data from this controlled feeding study suggest that the heterogeneous response of HDL-C and of apoA-I to the MedDiet, in the absence of weight loss, is primarily determined by variations in apoA-I FCR and in plasma triglycerides concentrations.

Comparison of UF and EDUF technologies for isolation and concentration of \textit{in vitro} anti-diabetic soy peptides.

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Many soybean compounds have been identified for their health benefits and since a few decades, research interests were focused on soy peptides. However, few fractions have already been identified for their metabolic activities. In this context, two kinds of separation technologies (pressure-driven, ultrafiltration (UF); electrically-driven, electrodialysis with ultrafiltration membranes (EDUF)) were compared for their potential in separating of bioactive soy peptides. Moreover, two conditions were studied for each technology: for UF technology, two membrane configurations were studied (a 10 kDa spiral wound membrane (SW) and a 10 kDa hollow fiber membrane (HF)), while two electric strength/UF membrane cut-off ratios were investigated in EDUF (5 V/10 kDa vs 50 V/100 kDa). After separations, fractions were tested \textit{in vitro} for their glucose up-take activities, using L6 muscular cells.

In spite of composition differences revealed by LCMS analysis, no effect was reported neither for HF configuration nor for EDUF at 5 V/10 kDa. However, significantly increased glucose uptakes were measured in cells treated with SW fractions (at 1 mg/ml) and EDUF 50 V/100 kDa fractions (at 1 \( \mu \)g/ml), with a
dose/effect correlation, indicating a potential anti-diabetic effect. Moreover, it was demonstrated by western blot experiments that the AMPk pathway, one of the major non-insulino dependent glucose uptake pathway, was activated by the 50 V/100 kDa EDUF fractions. Hence, it appeared that EDUF treatment used at 50 V/100 kDa would be a convenient mean for isolating and concentrating in vitro anti-diabetic peptides form soy hydrolysate, more efficiently than UF technology.

**Redox properties of catechins and enriched green tea extracts effectively preserve L-5-methyltetrahydrofolate (L-5-MTHF): Assessment using cyclic voltammetry analysis.**

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This study was performed to study the stability of the L-5-methyltetrahydrofolate (L-5-MTHF), a reduced and highly sensitive form of folic acid, in combination with epigallocatechin gallate enriched extract (EGCGe) and epigallocatechin enriched extract (EGCe). These green tea enriched extract have strong antioxidant capacity and are hypothesis to allow the L-5-MTHF preservation. Cyclic voltammetry (CV) measurements were performed in pH 5.5 Britton-Robinson buffer at room temperature on 1 mM L-5-MTHF in combination with EGCGe or EGCe. The combination of L-5-MTHF with enriched catechin extracts provided enhanced stability of L-5-MTHF over a period of 12h under ambient air conditions. CV experiments showed that increasing the concentrations of EGCGe or EGCe extracts from 80 to 400 mg/L produced a decrease in the second oxidation peak of L-5-MTHF. Thus, we calculated that L-5-MTHF remained at nearly 90 % when in the presence of enriched tea extracts, compared to 74 % without addition. The catechins responsible for this preservation were EGCG and C, confirmed by LC-MS testing. A strong interaction between the different catechins present in the tea extract to stabilize L-5-MTHF, as a covalent link, was not found. Rather, we hypothesize that EGCGe and EGCe extracts were effective agents to preserve L-5-MTHF, through a mechanism that involved hydrophobic bond between the gallate group of catechins and L-5-MTHF and also to the redox potential of catechins to maintain the L-5-MTHF in its reduced form.

**Production and Characterization of Angiotensin Converting Enzyme Inhibitory Peptides from Red Tilapia Protein Hydrolysates**

Shamloo, Maryam and Bakar, Jamilah

Fish proteins are considered as valuable nutrient and a good source of many bioactive peptides such as angiotensin converting enzyme (ACE) inhibitory peptides. Tilapia protein hydrolysates produced by enzymatic hydrolysis of Alcalase (AH), Flavourzyme (FH) and Protamex (PH) using pH-stat method were studied. The freeze-dried powders were then evaluated for their amino-acid composition, the
ACE (Angiotensin Converting Enzyme) inhibitory activity as well as their peptide patterns. The result indicated that Alcalase hydrolysates had the highest ACE inhibitory activity when compared to Protamex and Flavourzyme. The ratio of essential amino acids to non-essential amino acids increased after hydrolysis. SDS-PAGE patterns for all the protein hydrolysates showed a significant ($P < 0.05$) reduction in the number and the intensity of the bands. Alcalase hydrolysates produced in an optimum conditions were then fractionated using three different molecular weight cut-off membranes (10 kDa, 5 kDa and 2 kDa). All four fractions (> 10 kDa, 10-5 kDa, 5-2 kDa and < 2 kDa) showed the ACE inhibitory activity, however, the fraction with molecular weight of < 2 kDa, appeared to have a significantly ($p < 0.05$) higher ACE inhibitory activity compared to unfractionated hydrolysate, >10 kDa, 10-5 kDa, and 5-2 kDa fractions, indicating that ultrafiltration can be employed to enrich ACE- inhibitory activity in tilapia hydrolysates. Amino acid analysis of active fractions of tilapia protein hydrolysates indicated that hydrophobic amino acids play a prominent role in the inhibition of ACE.

Comparison of Antioxidant Activities of Different Commercial Flours and Their Resultant Bakery Products
Yu, Lilei

Antioxidant activities of commercial flours from five brands (containing both whole wheat flour and enriched white flour) were investigated. The effects of bread making process on their antioxidant activities were also studied. The methods employed were total phenolic content (TPC), 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging activity and oxygen radical absorbance capacity (ORAC). Overall, commercial flours demonstrated higher antioxidant activities than reported in the literature on milled wheat grain flours as samples. In the present investigation, whole wheat flour exhibited significantly higher antioxidant activity than enriched white flour in terms of TPC and ORAC values; however, for DPPH• scavenging activity at 60 min, whole wheat flour demonstrated slightly lower ability than enriched flour. Concerning the effect of bread making process, antioxidant activities of both whole wheat and enriched white flours decreased significantly in regard to the TPC and DPPH radical scavenging capacity; however, the results from ORAC assay indicated an increased antioxidant activity after the baking process which was possible due to the development of melanoidins, a product from Maillard reaction. The variation in results could be explained by the underlying mechanisms of the assays employed and the varying amounts of natural antioxidants present and reducing additives added in the commercial flours.