2010 Annual Meeting Abstracts

Health and Nutrition

MONDAY

MORNING
H&N 1: Lipids, Inflammation and Lipid Signaling Molecules
Chair(s): C. Lammi-Keefe, Louisiana State University, USA; and B. Flickinger, Archer Daniels Midland Co., USA

The Anti-Obesity Effects of Dietary Trans/Trans Conjugated Linoleic Acid-Rich Soy Oil on Fa/Fa Obese Zucker Rats. W. Gilbert[1], V. Gadang[1], A. Proctor[1], V. Jain[1], L. Katwa[2], L. Devareddy[1], [1]University of Arkansas, Fayetteville, AR, US, [2]East Carolina University, Greenville, NC, US

Conjugated linoleic acid (CLA) is the common name for a group of conjugated dieonic linoleic acid derivatives. Numerous experiments using the *cis*, *trans*- and *trans*, *cis*-CLA isomers have shown beneficial health effects. However, little has been done with the *trans*, *trans*-CLA isomers. We have previously reported on anti-obesity effects of *trans*, *trans*-CLA isomers fed as a dietary supplement. Here we evaluated the effects of *trans*, *trans*-CLA enriched soybean oil in improving glucose control, and examined the mechanism. Three-month old *fa*/*fa* and lean female Zucker rats (n=12/group) were fed either an AIN-93M or an AIN-93M + 0.5% *trans*, *trans*-CLA purified rodent diet for a period of 100 days. CLA supplementation improved glucose control as measured by glycated hemoglobin, and had an intermediary effect on fasting insulin. Gene expression was measured in cardiovascular and adipose tissue. Peroxisome proliferator-activated receptor-γ (PPAR-γ) and nuclear factor kappa B (NF-κB) were significantly up-regulated in cardiovascular tissue. The positive effects observed are thought to be the result of *trans*, *trans*-CLA functioning as a ligand activator of PPAR-γ. The *trans*, *trans*-CLA isomers show promise as anti-obesity compounds. However, further research is needed to confirm the most effective dose.

Endotoxin Absorption during the Digestion of Emulsified Lipids. M.C. Michalski[1,2], F. Laugerette[2,1], C. Soulage[2,3], A. Geloën[2,3], C. Vors[1,3], M. Alligier[4], M.A. Chauvin[2], S. Lambert-Porcheron[4], R. Burcelin[5], M. Laville[4,2], H. Vidal[2,1], N. Peretti[4], [1]INRA UMR1235, Villeurbanne, Rhône, France, [2]INSA-Lyon, Villeurbanne, Rhône, France, [3]INSERM U870, Villeurbanne, Rhône, France, [4]CRNH Rhône-Alpes, Oullins, Rhône, France, [5]I2MR, Toulouse, Haute Garonne, France

Recent patho-physiological studies have shown a role for inflammation in cardiovascular diseases and have highlighted a relationship between the onset of inflammation and nutrition, particularly high-fat intake. However, the mechanism of this subclinical inflammation is poorly understood. Recent reports have led to postulate that with high-fat diets, the profinflammatory lipopolysaccharides (LPS) of Gram negative bacteria in intestinal microflora would be absorbed along with the lipids. In this study, we aimed to elucidate the role of dietary lipids on intestinal endotoxin absorption during digestion and postprandial inflammation. In rats, lipid digestion was increased after feeding an emulsion compared to free oil. Moreover, the emulsion led to a 2.3-fold higher endotoxin accumulation in plasma than oil and 7-fold higher than a saline bolus. Strikingly, postprandial triglyceridemia and endotoxemia were correlated between the groups of rats force-fed with the different lipid bolus. In humans, endotoxemia and then IL-6 increased transiently in the postprandial period after consuming a meal with 33 g lipids (30% emulsified).Our results demonstrate that lipid digestion results in a transient accumulation of endotoxins in plasma, especially when the former are emulsified with phospholipids, that can contribute to low-grade inflammation.

Alpha-synuclein is a Key Regulator of Brain Inflammatory Response via its Regulation of Brain Arachidonic Acid Metabolism. Eric Murphy, University of North Dakota, Grand Forks, ND, USA

Alpha-synuclein (Snca) is a small cytosolic protein that is associated with several neurodegenerative diseases. Although many groups focus on the synaptic distribution of Snca, the ubiquitous distribution of Snca suggests a

broader role. We have examined the impact of Snca on brain lipid metabolism in vivo, using Snca KO mice, where it impacts brain arachidonic acid (ARA, 20:4n-6) metabolism via its interaction with an ER-localized long chain acyl-CoA synthetase (Acsl). This accounts for the reduction in brain ARA-CoA levels in these mice and the profound reduction in brain ARA incorporation from plasma pools. The observed reduction in Acsl activity is reversed by the addition of exogenous Snca to microsomes from KO mice, suggesting a potential protein-protein interaction. Because Snca binds monomeric ARA at with a low μM Kd, this interaction may also involve substrate presentation to the Acsl. The reduction in the kinetics of ARA incor by providing more free ARA for conversion to prostaglandins (PG). This is demonstrated in LPS treated mice and in mice subjected to short term ischemic insult where there is a two-fold increase in brain PG formation. Hence, Snca is emerging as a key regulator of brain inflammatory response via its modulation of brain ARA metabolism.

Fatty Acids and Inflammatory Processes. P.C. Calder, University of Southampton, Southampton, UK

Interest in the influence of fatty acids on inflammatory processes has centered on the frequently opposing actions of n-6 and n-3 PUFAs, although studies have demonstrated novel actions of saturated fatty acids that are again opposed by n-3 PUFAs. The n-6 arachidonic acid (ARA) gives rise to the eicosanoid family of mediators and through these regulates the activities of inflammatory cells, and the production of inflammatory cytokines, matrix metalloproteinases etc. Consumption of long chain n-3 PUFAs (EPA and DHA) decreases the amount of ARA in inflammatory cell membranes. Thus, consumption of long chain n-3 fatty acids results in decreased production of eicosanoids from ARA. EPA acts as an alternative substrate for eicosanoid synthesis giving rise to mediators that are often less potent than the analogues produced from ARA. EPA and DHA give rise to newly discovered families of mediators termed E- and D-resolvins, respectively, which have potent anti-inflammatory and inflammation resolving actions in cell culture and animal models. In addition to this range of effects on lipid mediators, long chain n-3 fatty acids also decrease production of some peptide mediators of inflammation including the classic inflammatory cytokines. These anti-inflammatory actions suggest that long chain n-3 fatty acids could be useful to protect against and to treat inflammatory conditions.

Specialized Pro-Resolving Mediators in Inflammation-Resolution from Omega-3 Oils. L.V. Norling[1,2], C.N. Serhan[1], [1]Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA, [2]William Harvey Research Institute, London, UK

A well-integrated inflammatory response and it?s ending, i.e. resolution, is essential for health. Since the resolvins and protectins control the duration and magnitude of inflammation, mapping these resolution circuits provide new avenues for exploring the molecular basis of many inflammatory diseases. Here, we overview recent advances on the biosynthesis and actions of novel anti-inflammatory lipid mediators, resolvins, protectins and maresins generated from essential omega-3 FAs (EPA & DHA). These novel lipid mediators were originally isolated from experimental murine models of acute inflammation during the natural spontaneous resolution phase; a new genus coined specialized pro-resolving mediators (SPM). SPM proved stereoselective, and possess potent anti-inflammatory, pro-resolving, and protective properties. The complete stereochemistry of Resolvin D2 (RvD2) was recently established as 7S, 16R, 17S-trihydroxy-4Z, 8E, 10Z, 12E, 14E, 19Z-DHA. RvD2 protects from murine microbial sepsis initiated by cecal ligation and puncture (CLP), decreasing local and systemic bacterial burden, excessive cytokine production and PMN infiltration, whilst enhancing containment of bacteria by phagocytes, ultimately increasing survival rates. Hence, defective mechanisms and pathways in resolution may underlie our current appreciation of the inflammatory phenotype(s) that characterize some prevalent human diseases.

N-3 Polyunsaturated Fatty Acids, Fatty Liver Disease, and Inflammation. D.B. Jump, M. Torres-Gonzalez, S. Tripathy, C. Depner, K. Hardin, Oregon State University, Corvallis, OR, USA

The frequency of non-alcoholic fatty liver disease (NAFLD) and non alcoholic steatohepatitis (NASH) have increased in parallel with the incidence of obesity in humans. While both diseases are characterized by an abnormal accumulation of neutral lipid in the liver, NASH is characterized by hepatic inflammation. C-reactive protein (CRP) expression and its appearance in blood is an early marker of hepatic inflammation. N-3 PUFA in fish oil have the capacity to attenuate both fatty liver and hepatic inflammation. Our group examined the effect of n-3 PUFA (fish oil)

on hepatic function in a mouse model of diet-induced obesity and fatty liver. LDL-R (-/-) mice were fed high fat-high cholesterol diets without and with fish oil supplementation for 12 weeks. The high fat-high cholesterol diets induced obesity, fatty liver, multiple changes in hepatic lipid composition & metabolism, and multiple markers of hepatic inflammation. Inclusion of fish oil in the diet reversed many of these effects, including hepatic neutral lipid storage, NFkappaB nuclear abundance, the expression of CRP, ApoC3 and multiple genes involved in saturated, mono- and polyunsaturated fatty acid synthesis. These studies identified multiple mechanisms by which high fat-high cholesterol diets & n-3 PUFA control hepatic lipid content, inflammation and VLDL composition.

Omega-3 Essential Fatty Acid Signaling Regulates Initiation and Progression of Neurodegenerative Diseases. N.G. Bazan, Louisiana State University Health Sciences Center, New Orleans, Louisiana, USA

The significance of omega-3 essential fatty acids in the nervous system is incompletely understood. We discovered a docosanoid synthesized from DHA, neuroprotectin D1 (NPD1), which is made in response to oxidative stress and brain ischemia-reperfusion. NPD1 is neuroprotective in experimental brain damage, oxidative-stressed RPE cells, and human brain cells exposed to amyloid-β peptide. We provide here examples of NPD1 specificity and potency: 1) In RPE cells, phagocytosis of photoreceptor membrane disks promotes via NPD1 synthesis specific refractoriness to oxidative stress-induced apoptosis. Disruptions of the sentinel role of NPD1 in photoreceptor renewal may participate in retinal degenerations leading to blindness. 2) In brain ischemia-reperfusion, DHA is released and used for NPD1 synthesis, thus eliciting neuroprotection. Anti-apoptotic BCL-2 proteins are positively modulated by NPD1, whereas pro-apoptotic BCL-2 proteins are negatively regulated. 3) NPD1 is reduced in CA1 areas of Alzheimer′s patients, and we have shown the significance of NPD1 in cellular models that mimic part of the Alzheimer′s pathology. NPD1 regulation targets upstream events of apoptosis and neuroinflammatory signaling, thus promoting homeostatic regulation of cell integrity. (Supported by NIH NINDS R01NS046741, NEI R01EY005121, NCRR P20RR016816)

Discussion.

AFTERNOON

H&N 2: Bioactivity and Emerging Benefits of Short and Medium Chain Fatty Acids

Chair(s): P. Jones, University of Manitoba, Canada; and P.J. Huth, PJH Nutritional Science, USA

Dietary Intakes, Food Sources and Bioactive Effects of Short and Medium Chain Fatty Acids. P.J. Huth[1], V. Fulgoni[2], [1]PJH Nutritional Science, Menomonie, WI, USA, [2]Nutrition Impact LLC, Battle Creek, MI, USA

Few studies have examined the dietary intake of short chain fatty acids (SCFA) and medium chain saturated fatty acid (MCFA) and their relationship to health. We have recently examined data from the 2003-2004 and 2005-2006 National Health and Nutrition Examination Survey to evaluate the dietary intake levels of the SCFA (C4:0), MCFAs C6:0 ? C12:0 and primary food sources. Overall, U.S. adults 19 yrs of age and older consumed an average of 0.6 g of SCFA and 1.8 g/day of MCFAs and together constituted 7.9% of total saturated fat intake. Compared to a total saturated fat intake of 11.19 percent of energy, SCFA and MCFAs intake accounted for 0.24 and 0.73 percent of energy, respectively. Milk and milk products and beef products are primary contributors of dietary SCFA and MCFA intake. Short and medium-chain fatty acids have physical and metabolic properties that are distinct from those of long-chain fatty acids which include being a readily available source of energy and unique metabolic features. MCFAs have been used for nutritional management of inherited long-chain fatty acid β-oxidation disorders and have been shown to improve clinical symptoms particularly cardiac hypertrophy and dysfunction. Experimental evidence suggests that MCFAs may also have benefits for metabolic therapy in the management of cardiac diseases in general. Additionally, several reports have shown these fatty acids also possess powerful antimicrobial, antiviral and antiparasitic properties. Studies have shown that C12:0 was the most potent bactericidal fatty acid against Enterococcae (Gram-positive), and C8:0 was the most potent against coliforms (Gram-negative).

Medium Chain Triglycerides: Target for Cardiovascular Disease and Insulin Resistance?. P.J. Jones, Richardson

Centre for Functional Foods and Nutraceuticals, University of Manitoba, Winnipeg, Manitoba, Canada

Cardiovascular disease (CVD) and insulin resistance are directly linked to overweight and obesity. Thus, any dietary strategy capable of causing weight reduction will lower CVD and diabetes risk. Oils rich in medium-chain triglycerides (MCTs) are one of several dietary components that have shown potential in the treatment of obesity. MCTs are less energy dense and highly ketogenic compared to long chain triglycerides (LCTs). MCTs also differ from LCTs in their digestive and metabolic pathway, since they are easily oxidized and utilized as energy, with little tendency to deposit as body fat. Ingestion of MCTs in low to moderate quantities may have considerable effects on the thermic effect of food (TEF). For instance, the difference in 24-h EE between 30 g of MCTs and 30 g of LCTs was 471 kJ; this increase in EE would extrapolate to about 0.45 kg of fat loss over a month if effects were to persist over that period. However, even smaller doses of MCTs of 5 to 10 g/d have been tested and shown to cause larger diet-induced thermogenesis than LCTs. Therefore, both small and large doses of MCTs increase EE; with larger doses creating greater effects on TEF which may be more beneficial for weight loss. In addition, MCTs may reduce body weight by enhancing satiety. Thus, unique nutritional properties of MCTs are believed to upregulate energy expenditure, suppress intake, thereby increasing weight loss, as well as suppressing body fat accumulation. As a logical interpretation of these observations, consumption of MCT-containing foods may contribute to control of CVD and diabetes risk in susceptible individuals.

Benefits of Medium Chain Triglyceride Consumption for Weight Management and Metabolic Syndrome. Marie-Pierre St-Onge, New York Obesity Research Center, St. Luke?s/Roosevelt Hospital and College of Physicians and Surgeons, Columbia University, New York, NY, USA

Animal studies have long shown that consumption of medium chain triglycerides (MCT) leads to lower fat deposition than equivalent consumption of long chain triglycerides (LCT). In humans, studies have shown that MCT consumption enhances thermogenesis and reduces food intake compared to LCT. Such effects have translated to enhanced weight loss in subjects consuming MCT oil compared to LCT-containing oils. Combined, these studies suggest a role of MCT for weight management and MCT oil has been advocated as a potential useful adjunct to a weight loss diet. On the other hand, there have been concerns about potential adverse metabolic effects of MCT. Early studies have shown that MCT consumption increases circulating triglyceride concentrations as well as total and low-density lipoprotein cholesterol in men compared to LCT consumption. These adverse effects have not been observed in more recent studies where subjects were given smaller amounts of MCT. In addition, recent studies have shown that post-prandial triglyceride concentrations are reduced in hypertriglyceridemic subjects consuming MCT compared to LCT. These studies thus provide evidence of a dual benefit of MCT consumption for the management of metabolic syndrome: (1) through improvements in body composition and adipose tissue reduction; and (2) via reductions in triglyceride concentrations.

Applications of Medium- and Short Chain Fatty Acids. Ronald J. Jandacek, University of Cincinnati, Cincinnati, OH, USA

Fatty acids of chain length more than 12 carbon atoms are absorbed from the intestine through lymphatic ducts. Fatty acids of chain length less than 12, are absorbed via the portal vein. This difference in absorption results in significant differences in metabolism. Long-chain fatty acids are packaged as triacylglycerols in chylomicrons that are delivered to tissues without a first pass through the liver. Medium-chain fatty acids are directed to the liver via the portal vein, are metabolized by hepatic enzymes, and are sparingly deposited in adipose tissue. Orally ingested fats with significant amounts of medium-chain fatty acids are hydrolyzed and absorbed when pancreatic lipases are sparingly present. This rapid hydrolysis has contributed to the formulation of fats made with medium-chain fatty acids for use in intravenous feeding to deliver energy to appropriate tissues. Reduced calorie fats have also been made from mixtures of fatty acids with disparate chain lengths. These fats can have unique properties that provide the hedonic properties associated with fluid fats and the low intestinal absorption of the long-chain saturated fatty acid components. This latter effect reduces energy available to the body and offers a formulation of reduced-calorie fats that can be used in cooking. The use and status of products incorporating short- and medium-chain fatty acids will be reviewed.

Panel Discussion.

TUESDAY

AFTERNOON

H&N 3: n-3, n-6 Benefits / Liabilities: Interactions, Competition

Chair(s): M. Craig-Schmidt, Auburn University, USA; E. Bailey-Hall, Martek Biosciences Corp., USA; and D.M. Bibus, Minnesota State University, USA

Overview of n-3 and n-6 PUFA Metabolism. J.T. Brenna, Cornell University, Ithaca, NY

It is long established that dietary n-3 and n-6 polyunsaturated fatty acid (PUFA) influence tissue PUFA levels. PUFA tissue levels compete for long chain PUFA (LCPUFA) biosynthesis, and the resulting compositional differences influence membrane composition and messenger synthesis. Linoleic acid (18:2n-6) tends to be stored in membranes and in adipose tissue whereas the major fate of linolenic acid (18:3n-3) is use as fuel or excretion on the skin. LCPUFA are key components of cell membranes and precursors for paracrine signalling molecules. They can be derived from biosynthesis or by dietary consumption of the preformed LCPUFA. Linoleic acid is converted to the LCPUFA eicosanoid precursors dihomo-gamma-linolenic acid (18:3n-6) and arachdonic acid (20:4n-6) via two and three metabolic steps, respectively. This is considered an efficient process, and there no dietary requirement for n-6 LCPUFA except possibly in infancy. In contrast, linolenic acid is desaturated and elongated to docosahexaenoic acid (DHA, 22:6n-3) by a pathway accepted to require eight steps and two organelles, and most measurements indicate that that this pathway is inefficient. Many studies show that DHA status as measured in the blood is not enhanced by supplementation of any amount of any precursor. Recent results on the pathways and genetics of LCPUFA biosynthesis may be relevant to requirements.

Dietary Intakes of n-6 and n-3 Fatty Acids and the Developing Infant. S.E. Carlson[1], J. Colombo[2], K. Gustafson[1], [1]University of Kansas Medical Center, Kansas City, KS, USA, [2]University of Kansas, Lawrence, KS, USA

Human milk, and, recently, infant formula, provide docosahexaenoic acid (DHA) and arachidionic acid (ARA), long chain polyunsaturated fatty acids of the omega-3 and omega-6 families, respectively. Randomized studies have evaluated the effects of dietary DHA (and in some cases ARA) on human infant visual acuity and early measures of cognitive development such as attention, processing speed, novelty preference, and problem solving. LCPUFA have been supplied at different stages of develop-ment through maternal (in pregnancy and lactation) and infant (formula) supplementation. Postnatal supplementation has occurred as early as the end of the 2nd trimester and as late as 6 months of age with different levels of supplementation. In recent years, the study outcomes of interest have broadened from visual acuity and cognitive development (which remain of interest) to development of the autonomic nervous and immune systems. Because omega-3 LCPUFA intake increases the omega-3 LCPUFA concentration of all cells studied to date, and because these fatty acids are understood to have many physiological functions, it is likely that other physiological systems are influenced by LCPUFA intake that have not yet been studied. Thus work in infant development is likely to continue but with comparison of different doses to the developmental outcomes of interest.

Dietary Intakes of n-3 and n-6 Fatty Acids in Neurological Health. J.R. Hibbeln, National Institute on Alcohol Abuse and Alcoholism/ NIH, Rockville, MD, USA

Depletions in tissue compositions of long chain omega-3 fatty acids in may impair optimal function of neural and immune system function. In a meta-analysis of 21 randomized placebo-controlled trials, interventions using EPA rich preparations, reduced major depressive symptoms within effect size of 1.0. The dietary intakes of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) of 900 mg/d (2,000 Cal.) are necessary to meet statistical criteria for Daily Recommended Intakes reducing risks of neuropsychiatric illnesses and 97.5% of the population (Hibbeln et al 2009). In humans, decreasing dietary linoleic acid from 7.8 en to % 1.7 en% increased the omega-3 index by 1.9 points (Clark et al, 1992). Direct dietary intakes of at least 750 mg of EPA/DHA are required to achieve this elevation for a 2,000 Cal. diet. In humans, linoleate lowering elevates EPA and DHA tissue compositions (Harris et al 2008, Schwartz 2009, Manukata et al 2009) Animal models comparing preagricultural diets 1% to 8 % en linoleate demonstrate

depletions in brain DHA composition (Novack et al 2008). Dietary advice to consume linoleic acid in excess of 2 en% likely lowers tissue EPA and DHA in humans and contributes to n-3 deficiency syndromes, including risk of neuropsychiatric illnesses.

Dietary Intakes of n-6 and n-3 Fatty Acids for Coronary Heart Disease: Summary of Evidence from Prospective Cohort and Randomised Controlled Trials. C. Murray Skeaff, Jody Miller, University of Otago, New Zealand

The effects of n-6 and n-3 fatty acids on metabolic and physiological processes linked to coronary heart disease suggest that these fatty acids should modify the risk of coronary heart disease. A systematic literature review was conducted to identify cohort and controlled trials of dietary n-6 and n-3 fatty acids and coronary heart disease. Summary estimates of the relative risk of coronary heart disease in high compared with low exposure to dietary n-6 and n-3 fatty acids were calculated using meta-analysis. The evidence from both observational studies and controlled trials was convincing that higher intakes of n-3 long chain polyunsaturated fatty acids lower the risk of coronary heart disease. Alpha-linolenic acid intake was not associated with reduced risk of coronary heart disease; however, the evidence was limited to a small number of observational studies. The evidence was also convincing that diets, which are both higher in polyunsaturated fatty acids ? predominantly n-6 fatty acids ? and lower in saturated fatty acids, reduce the risk of coronary heart disease. The balance of evidence from observational studies and controlled trials shows that n-3 and n-6 polyunsaturated fatty acids reduce the risk of coronary heart disease.

Dietary Intakes of n-6 and n-3 Fatty Acids and Cardiovascular Disease: Recommendations from the American Heart Association. W.S. Harris, Sanford Research/USD, Sioux Falls, SD, USA

This presentation will review the current recommendations from the American Heart Association?s Nutrition Committee for the two families of essential polyunsaturated fatty acids: omega-6 and omega-3. Although most clinician?s understand that the latter are beneficial, some nutritionists have called for reduced intake of linoleic acid, the principal dietary omega-6 fatty acid, because of presumed pro-inflammatory and pro-thrombotic effects. The AHA has published two ?Science Advisories,? one in 2002 on omega-3 fatty acids and another in 2009 on omega-6 fatty acids. Both considered a wide variety of data regarding their effects on cardiac risk. The AHA concluded that Americans need to increase their intake of long chain omega-3 fatty acids, and that they should maintain current (or possibly even increase) intakes of linoleic acid. For the omega-3 fatty acids, a healthy target intake is about 500 mg per day (whether from oily fish or fish oil capsules), and for linoleic acid, approximately 15 g per day (12 g for women and 17 g for men). Achieving healthy intakes of both omega-6 and omega-3 fatty acids is an important component of the nutritional prevention and treatment of CHD.

n-3 and n-6 Acids Compete for Accumulation as Highly Unsaturated Fatty Acids (HUFA) in Tissues. Bill Lands, none, USA

Quantitative accumulation of tissue HUFA from essential fatty acids (EFA) noted in 1963 was confirmed in 1990 and 1992 and reviewed in Prog Lipid Res. 47: 77-106 (2008). An empirical calculator estimating competing impacts of dietary EFA on the proportions of accumulated tissue HUFA is accessed at http://efaeducation.nih.gov/sig/dietbalance.html/ Quantitative aspects of mobilizing tissue HUFA to form n-3 and n-6 hormone-mediated responses were detailed by Wada et al. J Biol Chem. 282: 22254-22266 (2007). Quantitative associations of tissue HUFA proportions with CHD mortality rates were detailed by Lands in Lipids 38: 317-321 (2003). The HUFA-associated risk for CHD deaths per 100,000 people was estimated to be near 3x(%n-6inHUFA) - 75. Evidence supports a hypothesis that lowering the current level near 78% n-6inHUFA to 50% n-6inHUFA might lower CHD mortality rate by more than half, preventing over 200,000 deaths annually. Many social, ethical and financial concerns might be prevented by clear public information about food choices that maintain tissue proportions of HUFA at levels desired to cut unintended health risk. Interactive, personalized menu planning software is free from http://efaeducation.nih.gov/sig/kim.html/ to help plan primary prevention of what the Centers for Disease Control and Prevention regards as a preventable condition.

Recent Advances and Perspectives on the Role of Long Chain Polyunsaturated Fatty Acids in Bone Health. H. Weiler, McGill University, Montreal, QC, Canada

Dietary long chain polyunsaturated fatty acids (LCPUFA) affect bone in multiple species (mice, rats, guinea pigs, piglets and humans) and in a variety of physiological states (fetus, neonates, growth, pregnancy, lactation, adulthood and aging). Such interspecies and life stage studies reinforce the widespread biological role of LCPUFA in bone. The key LCPUFA modulating bone mass are n-6 arachidonic acid and n-3 eicosapentaenoic acid and docosahexaenoic acid. The physiological and cellular mechanisms behind the enhancing effects of LCPUFA on bone mass are postulated to stem from suppression of bone resorption by osteoclasts and enhanced bone formation by osteoblasts. To date the mechanisms are partially elucidated and originate from multiple systems including enhanced differentiation and maturation of mesenchymal stem cells into osteoblasts and attenuated differentiation and maturation of hematopoietic stem cells into osteoclasts. This session will provide an overview of the most recent advances and perspectives on the role of LCPUFA in bone health.

Fats and Fatty Acids Requirements for Adults. Ibrahim Elmadfa, Margit Kornsteiner-Krenn, University of Vienna, Institute of Nutritional Sciences, Vienna, Austria

The recommended intake level (acceptable macronutrient distribution range, AMDR) for total fat intake (TFI) varies from 20 to 35% of energy (E) per day. The minimum level (MIL 15%E) garantees an adequate intake of essential fatty acids (FAs) and affords the absorption of lipid soluble vitamins. Regardless of the macronutrient distribution range (%E), energy balance, dietary patterns and optimal nutrient intakes are also important for a healthy bodyweight.The intake of saturated FAs should not exceed a maximum level (MAL) of 10%E. The MIL for essential FAs is 3%E (whereas 2.5%E from linoleic acid, LA plus 0.5%E alpha-linolenic acid) to prevent deficiency symptoms, while the MIL for chronic disease prevention is 6%E. The MAL is considered by 11%E to balance the risk of lipid peroxidation. Arachidonic acid is not essential for a healthy person who gets enough LA (>2.5%E) from the normal diet. The AMDR for n-3 FAs ranges from 0.5 to 2%E. The intake of preformed n-3 long-chain polyunsaturated fatty acids (LCPUFAs) from eicosapentaenoic and docosahexaenoic acid (AMDR 250 to 2000 mg/d) is recommended. The trans FA intake from all sources should be restricted to 1%E. The recommendation of monounsaturated FAs is calculated by the difference from the TFI (MIL 15, MAL 35%E) minus saturated FAs (MAL 10%E) minus polyunsaturated FAs (MIL 3%E; MAL 11%E) minus trans FAs (UL 1%E).

WEDNESDAY

MORNING
H&N 4: General Nutrition I
Chair(s): H. Durham, Louisiana State University, USA; and J. Lambert, University of Alberta, Canada

Regulation of Adipocyte Differentiation by Marine Allene Carotenoids. Mi-Jin Yim , Masashi Hosokawa, Kazuo Miyashita, Hokkaido University, Minato, Hakodate, Hokkaido, Japan

Fucoxanthin is a major marine carotenoid found in edible brown seaweeds, has potential health benefits. Dietary fucoxanthin is metabolized to fucoxanthinol and amarouciaxanthin A, and detected in white adipose tissue and liver as well as plasma. We have reported suppressive effects of fucoxanthin and fucoxanthinol on the differentiation of 3T3-L1 preadipocytes to adipocytes. However, effects of amarouciaxanthin A on adipocyte differentiation are unknown. In the study, we examined the effects of amarouciaxanthin A on 3T3-L1 adipocyte differentiation. Amarouciaxanthin A suppressed lipid accumulation and decreased glycerol-3-phosphate dehydrogenase (GPDH) activity, which are indicators of adipocyte differentiation. The suppressive effects of amarouciaxanthin A were stronger than that of fucoxanthinol. In 3T3-L1 cells treated with amarouciaxanthin A and fucoxanthinol, peroxisome proliferator-activated receptor γ (PPAR γ), which regulates adipogenic gene expression, was markedly down-regulated. In addition, amarouciaxanthin A inhibited the mRNA expression of CCAAT/enhancer-binding protein (C/EBP) α which are the central determinants of the transcriptional factor on adipocyte differentiation. These results show amarouciaxanthin A inhibits adipocyte differentiation through down-regulation of PPARγ and C/EBPα mRNA.

Effects of n3 Intake on Plasma Phospholipid Fatty Acids and Sex Hormone Profiles in Postmenopausal Women: Potential for Breast Cancer Risk Reduction. S. Raatz[1,2], L. Orr[2], B. Redmon[2], M. Kurzer[2], [1]USDA Human

Nutrition Research Center, Grand Forks, ND, USA, [2]University of Minnesota, Minneapolis, MN, USA

Breast cancer risk is associated with dietary fat intake. Omega-6 fatty acids (n6) promote while omega-3 fatty acids (n3) inhibit tumorigenesis. Increased sex hormone (SH) concentrations are associated with risk of breast cancer. The effects of total fat and n3 on SH and PLFA were assessed in a feeding trial in 17 postmenopausal women. Diets tested in 8-week feeding periods were: 40% fat (HF), 20% fat (LF) and a low fat diet +n3 (23% fat; LFn3). PLFA n-3 (18:3n3, 20:5n3, 22:6n3 and total n3) increased and n6 (18:2n6, 20:4n6) reduced with LFn3 (all $p < 0.0001$). Estradiol (E2) increased with HF (17.2 ± 7.6 pmol/L) and decreased (-13.2 ± 7.9 pmol/L) with LF ($p = 0.03$). SH binding globulin reduced with LF and LFn3 compared to HF ($p = 0.06$). Free E2 index was reduced with LF (-0.004 ± 0.0004) and increased with HF (0.0006 ± 0.0004) ($p = 0.18$). Estrone reduced with LFn3 relative to HF and LF ($p = 0.14$). Free testosterone was increased with LF compared to HF and LFn3 ($p = 0.10$. The LFn3 diet changed PLFA in favor of n3. HF resulted in increased in E2, which is related to increased risk of breast cancer. LF resulted in reductions in E2 and free E2 index and LFn3 resulted in reduction in circulating estrone, which are related to decreased risk of breast cancer.

Upregulated Liver Synthesis-secretion in Awake Rats of Docosahexaenoic (DHA) and Arachidonic acids from Circulating Unesterified 18-carbon Precursors When DHA is Removed from the Diet. F. Gao, S. Rapoport, M. Igarashi, National Institutes of Health, Bethesda, MD, USA

The long-chain n-6 and n-3 PUFAs, arachidonic acid (AA, 20:4n-6) and docosahexaenoic acid (DHA, 22:6n-3), obtained from diet or derived from their 18-carbon precursors, linoleic acid (LA, 18:2n-6) and α-linolenic acid (α-LNA, 18:3n-3), help to maintain nervous system and cardiac integrity. The liver synthesizes and secretes the long chain PUFAs from their precursors and supplies them to extrahepatic tissues. In this study, we measured liver synthesis-secretion rates in rats fed a DHA-free, n-3 PUFA- adequate diet (4.6% α-LNA, no DHA) or a DHA supplemented diet (DHA 2.3%) for 15 weeks by using 2h infusion of unesterified [U- 13C]LA or α-LNA in rats [1]. The liver daily secretion rates of DHA and AA on the adequate diet, compared with rates in rats fed the DHA-supplemented diet, were increased by 80% and 61%, respectively. Our results indicate that the liver has the capacity to upregulate the biosynthesis and secretion of DHA and AA from their respective 18C precursor, when dietary DHA is absent from the diet. Such upregulation may help to meet the requirement of DHA and AA for other organs, such as brain and heart. This work was entirely supported by the Intramural Program of NIH. 1. Gao F, et al. J Lipid Res 2009 Apr;50(4):749-75

Targeting Cancer Stem Cells (CSC) with Dietary Compounds. Jack Losso, Louisiana State University Agricultural Center, Baton Rouge, LA, USA

Clinical Preparation of Erythrocytes Can Influence Fatty Acid Composition. T.L. Smith, A.C. Patterson, A.H. Metherel, K.D. Stark, University of Waterloo, Waterloo, ON, Canada

Analytical differences in fatty acid analyses are considered a significant hurdle for the development of risk factors based on fatty acid levels in blood. The impact of heparin versus EDTA, saline washing versus no saline washing, and immediate sample processing versus a 3 hour delay on fatty acid compositions expressed as concentrations and relative percent are examined. In addition, these variables were examined before, during and after fish oil supplementation. As expected, saline washing was associated with significant differences in fatty acid composition, whereas time and type of anticoagulant had no effect.

Lipid Emulsion for Neurological Disease. P. Kane, T. Wnorowski, K. Bieber, M. Speight, NeuroLipid Research, Millville, NJ, USA

Examination of subjects with Alzheimerâ??s, Parkinsonâ??s, Motor Neuron Disease, Autism, Multiple Sclerosis, Post Stroke over the past eleven years in 9000 analyses at Kennedy Krieger Instituteâ??s Peroxisomal Diseases Laboratory has revealed a characteristic accumulation of very long chain fatty acids (VLCFAs), which comprise lipid rafts,

ceramides, revealing cell membrane derangement. Membrane phospholipid abnormalities with elevation of VLCFAs may be indicative of exposure to fat soluble neurotoxins resulting in suppressed peroxisomal beta oxidation of VLCFAs. The use of oral and IV lipids with methylation factors may facilitate stabilization of phospholipids in cellular membranes thereby addressing cell membrane integrity and function. Application of intravenous phenylbutyrate may address neuroinflammation by increasing the beta oxidation of VLCFAs while phosphatidylcholine may suppress their formation. To stabilize membrane function we have utilized a clinical treatment plan for the past 7 years to address the accumulation of aberrant lipids and ceramides with oral and IV lipids and phospholipids. We have noted significant and sustained clinical neurological improvement within the first few weeks after initiation of oral and intravenous treatment in our patient population of 300 subjects.

Beneficial Effects of Dietary Docosahexaenoic Acid in a Mouse Model for Alzheimer's Disease. C. Bascoul-Colombo, R. Nair-Roberts, V. Stahl, K. Hall, C. Hughes, M. Good, J.L. Harwood, Cardiff University, UK

The Tg 2576 mouse contains the Swedish mutation of the human amyloid precursor protein (APP) and consequently accumulates amyloid plaques from 10-12 months of age. Such plaques are one of the characteristics of Alzheimer's disease and, like human patients with AD, Tg mice show learning and memory deficits. We have used this well-known model to examine any beneficial effects of dietary docosahexaenoic acid (DHA) which have been seen in several large human clinical trials.The Tg mice accumulated increasing plaque loads with time and showed impaired performance on some behavioural tests (e.g. T-maze, foraging). In general, Tg animals fed DHA exhibited improved task performance although this was variable. In addition, we examined changes in brain lipids in some detail as well as the expression of genes associated with inflammation, such as those for cytokines and cyclooxygenases.The data will be discussed in terms of the amyloid model for Alzheimer's disease.

Regulation of Plasma Endocannabinoids during the Second and Third Trimesters of Pregnancy. H.A. Durham[1], J.T. Wood[2], J.S. Williams[1], A. Makriyannis[2], C.J. Lammi-Keefe[1], [1]Louisiana State University, USA, [2]Center for Drug Discovery, Northeastern University, Boston, MA, USA

Endocannabinoids are endogenous cannabinoids that are lipid messengers and analogs of polyunsaturated fatty acids. Anandamide (AEA), an endocannabinoid ethanolamide, has been shown to modulate implantation and be associated with early pregnancy success. However, little is known about concentrations during the course of pregnancy or its congeners, palmitoylethanolamine (PEA) and oleoylethanolamine (OEA). We quantified plasma AEA, PEA and OEA of 67 women at 20-22, 23-26, 32 and 38-40 weeks of pregnancy using liquid chromotography-mass spectrometry. During pregnancy the measured ethanolamides increased by delivery (mean ± SD): AEA (0.68 ± 0.19 pg/µl to 0.88 ± 0.40 pg/µl, $p<0.01$), PEA (4.27 ± 1.49 pg/µl to 5.51 ± 1.73 pg/µl, $p<0.01$) and OEA(3.72 ± 1.35 pg/µl to 5.76 ± 2.29 pg/µl, $p<0.01$). In conclusion, these data support a synergistic function of AEA, PEA and OEA during successful pregnancy. Funded in part by: LSU AgCenter, Nestle, Ltd (Switzerland) and Agriculture and Food Research Initiative Grant 2009-65200-05991 from the USDA National Institute for Food and Agriculture.

Soleus Preferentially Accumulates Labelled Linoleate and α-linolenate as Compared with Red and White Gastrocnemius Muscles. P. Charkhzarin, H. Izadi, K.D. Stark, University of Waterloo, Canada

The appearance and disappearance of stable isotope labeled fatty acids using a novel internal isobutane positive chemical ionization (PCI) GC-MS technique were examined in rat soleus, and red and white gastrocnemius muscles. Accumulation in heart muscle was also examined as a reference measure. Rats were orally administered a single dose of a mixture of 4 isotopes (0.15 mg/g body weight each of ethyl $^{13}C_{18}$-18:2n-6, ethyl $^{2}H_{5}$-18:3n-3, ethyl $^{13}C_{16}$-16:0, and nonesterified $^{2}H_{2}$-18:1n-9) or vehicle only (olive oil) as a control. Groups of animals were sacrificed at 8, 24, and 48 h after dosing and muscle samples were collected and analyzed for isotopic signal of the labeled precursors and potential longer chain metabolites. In general, soleus accumulated higher concentrations of labeled fatty acids as compared with red and white gastrocnemius muscles. Concentrations of $^{13}C_{18}$-18:2n-6 and $^{2}H_{5}$-18:3n-3 tended to peak at 8 hr and decline afterwards in all muscles. In the skeletal muscles, the accumulation of labeled longer chain metabolites was variable and differed from steady accumulation as observed in the heart. In conclusion, the distribution of various polyunsaturated fatty acids differs in muscle types and may be associated to the fiber type composition of

individual muscles.

Response of Liver Transplant Patients to Hypolipidemic Dietary Intervention: Role of Lipogenesis. J.E. Lambert[1], V.G. Bain[2], A.B.R. Thomson[2], E.A. Ryan[2], M.T. Clandinin[1,2], [1]Alberta Institute for Human Nutrition, Edmonton, AB, Canada, [2]Department of Medicine, University of Alberta, Edmonton, AB, Canada

Blood lipid elevation after transplant is commonly attributed to immunosuppressive drugs. The objective was to investigate the lipid-lowering effect of a diet intervention, and role of lipogenesis in response to dietary therapy in transplant patients. Post-liver transplant (Transplant; 1F and 5M; age 55.83+5.38y) and healthy (Control; 5F and 2M; age 52.71+12.47y) subjects completed a 4-week trial with supplements containing functional ingredients (fish oil, phytosterols, and fibers). Deuterium-labeled water was given and fasting blood samples were taken pre and post. Samples were analyzed for triglyceride (TG) and total (TC) and LDL-cholesterol (LDL-c). Stable isotope analysis performed on plasma and VLDL TG estimated whole-body and hepatic lipogenesis of total and individual fatty acids (FA). The intervention significantly lowered TC and LDL-c ($p<0.05$), and lowered TG in those with higher baseline levels ($p<0.01$) in the Control group, but had no effect in the Transplant group. In Control, the intervention reduced whole-body and hepatic lipogenesis of total and individual FA 50%. In Transplant whole-body lipogenesis was reduced 30%, with no reduction in hepatic lipogenesis or most individual FA. Results suggest immunosuppression may have aberrant effects on hepatic lipid metabolism that alters response to dietary treatment.

Gamma-Tocotrienol as an Effective Agent in Targeting Prostate Cancer Stem Cell-like Populations for Cancer Prevention. W.N. Yap[1], M.T. Ling[2], Y.L. Yap[1], [1]Davos Life Science Pte Ltd., Singapore, Singapore, [2]Queensland University of Technology, Brisbane, Australia

Gamma-tocotrienol (γT3) can selectively kill the prostate cancer (PCa) cells and sensitize the cells to docetaxel-induced apoptosis. Here, the pharmacokinetics of γT3 and the in vivo cytotoxic response of androgen-independent prostate cancer tumor (AIPCa) following γT3 treatment were investigated. After intra-peritoneal injection, γT3 rapidly disappears from serum and selectively deposit in AIPCa tumor. Administration of γT3 for two weeks resulted in significant shrinkage of AIPCa tumor. Meanwhile, further inhibition of AIPCa growth was achieved by combined γT3-docetaxel treatment (p value<0.002). The in vivo cytotoxic effects induced by γT3 seem to be mediated through the decrease in expression of cell proliferation markers (PCNA, Ki67 and Id1) and activation of caspase cascades (cleaved caspase 3 and PARP). Additionally, we demonstrate for the first time that γ-T3 can down-regulate the expression of prostate cancer stem cell markers (CD133/CD44) in AIPCa cell lines (PC-3 & DU145), as evident from Western blotting and flow cytometry analysis. Meanwhile, spheroid formation ability of the prostate cancer cells was significantly hampered by γ-T3 treatment. More importantly, pre-treatment of PC-3 cells with γ-T3 was found to interfere with the tumor initiation ability of the cells. Overall, our results indicated that γT3, either alone or in combination with docetaxel, may provide a treatment strategy that can improve therapeutic efficacy against AIPCa while reducing toxicity often seen in patients treated with docetaxel.

Effects of Dietary Saturated Fatty Acids on Human Subclinical Inflammation and Blood Lipid. Voon Phooi Tee[1,2], Tony Ng Kock Wai[1], Verna Lee Kar Mun[1], Kalanithi Nesaretnam[2], [1]International Medical University, No. 126, Jalan 19/155B, Bukit Jalil, 57000 Kuala Lumpur, Malaysia , [2]Malaysian Palm Oil Board, 6, Persiaran Institusi, Bandar Baru Bangi, 43000 Kajang Selangor, Malaysia

Effects of dietary saturated fatty acids on markers of inflammation and blood lipid have not been widely reported. Our study was to investigate whether dietary saturated fats from palm olein (POo) and coconut oil (CO) have an influence on inflammatory markers and blood lipid compared to olive oil (OO). A randomised; single blinded and crossover intervention with 3 dietary sequences of 5wk each and 2 wk wash-out in between was conducted. 45 healthy subjects completed the study. The test fat contributed 2/3 of total dietary fat (30% en) in a 5-day rotation menu. There were no differences found in the effects of the three diets on high sensitive C-reactive protein, interleukin-6, interleukin-1β and tumor necrosis factor-α in fasting and non-fasting serum samples. There were also no differences found for triglycerides, total-, HDL- and LDL-cholesterol levels between POo and OO. However, CO increased both fasting and non-fasting HDL- and LDL-cholesterol compared to OO ($P<0.05$). CO raised non-fasting total cholesterol compared to POo ($P<0.05$) or OO ($P<0.01$) and also raised fasting serum total cholesterol compared to OO ($P<0.001$). Unlike

palmtitate in POo and oleate in OO, laureate in CO showed detrimental effects on blood lipid while inflammatory markers concentrations in human were not altered.

AFTERNOON
H&N 5: General Nutrition II
Chair(s): S. Raatz, USDA, ARS, NPA, USA

Inhibition of Breast Cancer Cell Hsp90 and Client Oncoproteins by Black Seed (*Nigella sativa*) Oil. N. Karki, J. Losso, Louisiana State University Agricultural Center, Baton Rouge, LA, USA

The Supply of Naturally Sourced Plant Seed Oils Containing Stearidonic Acid ? A Decade of Multidisciplinary Research. Keith Coupland[1,2], Andrew Hebard[1], [1]Technology Crops International, Winston?Salem, NC, USA, [2]Centre for Advanced Lipid Research, The University of Hull, UK

Interest in plant derived sources of stearidonic acid (SDA) has increased over the past ten-years driven, initially, by the appreciation that, in principal, SDA can be converted in mammals? to eicosapentaenoic acid (EPA). EPA is well accepted in being of nutritional importance in moderating inflammatory disorders, particularly cardiovascular disease. The accepted source of EPA historically has been fish body oils. What was once thought to be an inexhaustible source of oils containing long-chain poly-unsaturated fatty acids (LCPUFAs) such as EPA is now in doubt owing to over-exploitation and climate change. Renewable sources of n3 LCPUFAs are of current interest. However, the most abundant n3 LCPUFA, linolenic acid is poorly converted to EPA and the aim of ?engineering? EPA in to plant seed oils is proving elusive.Recent research by us and others has demonstrated the value of SDA in nutritional, medicinal and personal-care applications. It is becoming apparent, however, that the physiological and biochemical effects of SDA are not entirely the result of SDA to EPA conversion. In some applications SDA may be more effective than EPA.Successful commercialization of plant seed oils containing SDA has been achieved and currently there are two (non-GM) natural plant sources of SDA and GM-soybean oil containing high levels of SDA. The economic production of natural sources of SDA and the future opportunities for SDA-containing seed oils will be presented.

Effect of Dietary Plant Epidermal Wax on Blood Glucose Level in KKAy Mice. Nakamichi Watanabe[1], Chisa Nanbu[1], Yuko Sawano[1], Yuri Takeo[1], Kenshiro Fujimoto[2], Yoshio Takamura[3], Masaru Takumi[4], [1]Showa Women's University, Tokyo, Japan, [2]Koriyama Women's University, Fukushima, Japan, [3]Okinawa Sugar Canes Research Corporation, Okinawa, Japan, [4]KOYO SANGYO Co., Ltd., Tokyo, Japan

Policosanols, such as hexacosanol (C26), octacosanol (C28), and triacontanol (C30), are homologs of primary alcohols present in the epidermal wax of plants such as sugar-cane. Dietary octacosanol is known to increase physical endurance and decrease the levels of plasma triglycerides, total cholesterol, and low-density lipoprotein (LDL) -cholesterol. Although the mechanism underlying these effects is yet to be elucidated, it has been reported that dietary policosanol is metabolized into polycosanal and polycosanoic acid. Policosanals, such as octacosanal and triacontanal, are present in sorghum. In this study, we used type 2 diabetes model mice (KKAy) and investigated the effects of dietary sugar-cane wax (containing policosanol) and sorghum wax (containing polycosanals) on the levels of blood lipids, glucose, and insulin. The levels of total plasma cholesterol, glucose and insulin were decreased in the group fed sorghum wax, but not sugar-cane wax. However, the body weight, weights of some organs, and levels of plasma high-density lipoprotein (HDL)-cholesterol, and triglycerides of the dietary groups were not different. These results suggested that dietary policosanal might be effective in preventing diabetes. However, further research is required to elucidate the mechanism underlying this effect.

Alpha-linolenic Acid is a Key Dietary Source of N-3 Fatty Acids: What Kinetics Tells Us. Eric Murphy, University of North Dakota, Grand Forks, ND, USA

A number of studies demonstrate that alpha-linolenic acid (ALA, 18:3n-3) is converted to longer chain n-3 fatty acids, although this systems ability to provide adequate n-3 fatty acids is controversial. The bases of this controversy is the large amount of dietary ALA subjected to β-oxidation, although all dietary fatty acids have a similar level of β-oxidation. The low amount of ALA conversion in brain adds to this controversy. We have hypothesized that ALA conversion to longer n-3 fatty acids is a tissue specific event, with tissues such as brain, and liver capable of making DHA from ALA, whereas heart and skeletal muscle lack this ability. Recent kinetic analysis shows that the liver can supply the bodies requirements for long chain n-3 fatty acids, including DHA, from elongation of dietary ALA. This is especially important as recent evidence indicates the adult brain requires only 5 mg of DHA per day, an amount that can be made in the brain itself if sufficient dietary ALA is consumed. Evidence in human and rodent models demonstrate that mammals convert ALA to longer chain n-3 fatty acids. Thus, when sufficient levels of dietary ALA are consumed, the requirements for additional n-3 fatty acid consumption are reduced and the need for these other n-3 atty acids is met via the conversion of dietary ALA.

Inhibition of Pancreatic Cancer Cells by Black Seed Oil. N. Magazine, J. Losso, Louisiana State University Agricultural Center, Baton Rouge, LA, USA

Inhibition of Oncogenic Enzymes in Breast Cancer Cells by Black Seed (*Nigella sativa*) Oil. T. Jombai, J. Losso, Louisiana State University Agricultural Center, Baton Rouge, LA, USA

SDA Soybean Oil: Nutritional Rationale for a Land-Based Source of Heart Healthy Omega-3 Fatty Acids. S. Lemke[1], D. Goldstein[1], W. Harris[3], E. Krul[2], R. Wilkes[1], [1]Monsanto Company, St. Louis, MO, USA, [2]Solae, LLC, St. Louis, MO, USA, [3]Sanford Research/USD, Sioux Falls, SD, USA

Cardiovascular health benefits of the long chain polyunsaturated fatty acids (LCPUFAs), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are well documented. The US populationsâ?? dietary intake of LCPUFAs continues to be far below what would be considered by experts to be adequate for optimal health. The key to increasing omega-3 fatty acid intake may be to encourage intake of a wider range of foods enriched in omega-3 fatty acids that suit their usual dietary habits. A soybean that produces 20-30% w/w stearidonic acid (SDA SBO) has been developed through biotechnology. SDA is a metabolic intermediate between alpha-linolenic acid (ALA) and EPA, and enters the metabolic pathway after the inefficient desaturation step catalyzed by delta-6 desaturase. In a recent clinical trial, subjects who consumed SDA SBO for 12 weeks had 316% increased EPA levels in red blood cells (RBC) compared to a commodity soybean oil control ($p<0.001$). Relative to a group treated with EPA ethyl esters, SDA SBO increased RBC EPA with about 18% efficiency. Further, a significant reduction of 26-30% was observed in SDA or EPA treatment vs. control ($p=0.029$) for a subset of subjects with greater baseline triglyceride levels (>150 mg/dL). In conclusion, SDA SBO may offer a convenient source for consumers to increase their intake of heart healthy omega-3 fatty acids.

Health and Nutrition Posters

Chair(s): C. Lammi-Keefe, Louisiana State University, USA

Canola and Flax Oils Attenuate Development of Obesity and its Associated Complications in Obese-prone Rats Fed High Fat Diets.

D. Durston[1], P. Zahradka[1,2], C. Taylor[1], [1]University of Manitoba, Winnipeg, MB, Canada, [2]CCARM, Winnipeg, MB, Canada

Obesity does not occur in isolation but is typically accompanied by insulin resistance, hyperlipidemia and hepatic

steatosis. Given the current worldwide obesity epidemic and the large consumption of fats in the diet, there is an urgent need to identify fatty acid compositions that can prevent obesity. To address this concern, 6 wk old Obese Prone Sprague Dawley rats were fed high fat (55% energy) diets consisting of various fat types including canola oil, a canola/flax oil blend, safflower oil, or lard for 12 wks. The canola oil and canola/flax oil-fed rats had the lowest body weight and less weight gain compared to safflower oil and lard-fed rats. The canola, canola/flax, and safflower oil-fed rats also had the lowest fasting serum glucose. Additionally, the canola/flax oil group had the lowest percentage of hepatic lipid, whereas the safflower oil-fed rats had the highest liver lipid. Interestingly, both the canola/flax and the safflower oil-fed rats had the lowest serum triglyceride, suggesting that serum triglycerides do not necessarily reflect the level of hepatic steatosis. In conclusion, the canola/flax oil diet which was highest in omega-3 polyunsaturated fatty acids seemed to have the most beneficial effect for reducing development of obesity & its related complications.

Nutraceutical Potential of Wheat Germ Oil for Lipid Profile Management.

Muhammad Arshad[1], Faqir Anjum[2], Asma Bajwa[3], [1]University of Sargodha, Sargodha, Punjab, Pakistan, [2]University of Agriculture, Faisalabad, Faisalabad, Punjab, Pakistan, [3]Punjab Medical College, Faisalabad, Faisalabad, Punjab, Pakistan

Cookies were prepared from WGO with the objective of providing higher antioxidant content in the diet. Normal shortening was replaced with WGO at the levels of 0, 25, 50, 75 and 100% in the cookies formulation. The Î±-tocopherol content was 1660mg/kg in the WGO. Fatty acid profile of WGO revealed the content of oleic acid (14.69%), linoleic acid (56.99%) and linolenic acid (9.51%). The Î±-tocopherol content of cookies improved significantly with gradual increase of WGO in cookies formulation, however sensory attributes of the cookies containing WGO up to 50% were as acceptable as control cookies. Above which the sensory characteristics of cookies were affected negatively. The biochemical effects of the cookies were assessed through weanling albino rats by feeding a diet of cookies (10 % protein basis) for three months. The results indicated a significant decrease in serum cholesterol and LDL (Low density lipoprotein) concentration of serum of rats fed over diets containing WGO against the control group. High density lipoprotein (HDL) concentration was not affected by the treatments during the study. These findings support the nutritional value of wheat germ whose combined effects play a crucial role in reducing lipid peroxidation, which is ultimately useful in decreasing the risk of cardiovascular diseases.

Effect of Protamine on Lipid Metabolism in Rats.

Hosomi Ryota[1], Fukunaga Kenji[1], Hirofumi Arai[2], Seiji Kanda[3], Nishiyama Toshimasa[3], Munehiro Yoshida[1], [1]Kansai University, Suita, Osaka, Japan, [2]Kitami Institute of Technology, Kitami, Hokkaido, Japan, [3]Kansai Medical University, Moriguchi, Osaka, Japan

In this study, we examined the effects of dietary protamine on serum and liver lipid levels and liver metabolism in rats. As parameters of lipid metabolism, serum and liver cholesterol and triacylglycerol contents, the fecal excretion of lipid, and the liver expression of genes encoding proteins involved in lipid homeostasis were examined. Furthermore, we determined in vitro assays related to both the micellar solubility of cholesterol and the binding capacity of bile acid of casein and protamine peptic hydrolysate. After 4 weeks of feeding 5% protamine in the diet, markedly decreased serum and liver cholesterol and triacylglycerol levels were noted. Carnitine palmitoyltransferase-2 and acyl-CoA oxidase activities, key enzymes of fatty acid β-oxidation in mitochondria and peroxisomes, in the liver were increased in rats fed on protamine. Furthermore, enhancement of the fecal excretion of cholesterol and bile acid and increased mRNA expression levels of ATP-binding cassette (ABC) G5 and ABCG8 were observed in the liver. The micellar solubility of cholesterol was significantly lower in the presence of protamine peptic hydrolysate compared with casein peptic hydrolysate. These results suggest that dietary protamine has beneficial effects that aid in the prevention of lifestyle-related disease.

A Determination of Vitamin D Status and Intake of Pregnant and Non-pregnant Saudi Arabian Women.

W. Azhar, N. alTheyab, G. Liepa, Eastern Michigan University, Ypsilanti, MI, USA

The objective of this study was to determine serum 25(OH) and parathyroid hormone (PTH) concentrations as well as vitamin D and calcium dietary intake of healthy pregnant and non-pregnant Saudi Arabian women. Variables such as skin color and use of sunscreen were correlated to vitamin d status. Approximately half of the women had 25(OH)

vitamin D concentrations that were < 11 ng.ml. PTH concentrations were in the "normal to high" range. Although dietary vitamin D intake was in the normal range, calcium intake was very low. Vitamin D deficiency appeared to be prevalent in Saudi Arabian women.

Lipid Metabolism in Rats Fed Cholesterol-enriched Diets.
R. De Schrijver, D. Vermeulen, Catholic University Leuven, Leuven, Belgium

From 9 days before mating until day 15 of lactation, rats were fed a control diet or this diet enriched with 0.9% cholesterol (CHOL). Blood samples were taken on gestation day 13, day of parturation and lactation day 14. Milk was sampled on lactation days 1, 4 and 14, brain and liver tissues on lactation day 14. Cholesterol intake did not significantly influence body and brain weight of the pups. Adult rats and neonates of the CHOL group showed significantly elevated liver weight; at 2 weeks of age liver weight of the offspring was no longer affected. Adult rats of the CHOL group showed significantly higher triglyceride and cholesterol contents in the liver; these effects were not found in the offspring. Cholesterol content of colostrum was increased in the CHOL group; however, this effect was not observed in milk samples taken on day 14. The milk fatty acid profiles in the CHOL group showed elevated contents of 16:1n-7, 18:1n-7, 18:1n-9 and lower contents of 18:2n-6 and 18:3n-3. During gestation as well as lactation, plasma triglyceride and cholesterol contents were significantly increased in the dams fed the CHOL diet; a similar although less pronounced effect, was noted in the pups of this group. Brain cholesterol and fatty acid profiles in adult rats and offspring were not substantially affected by dietary treatment.

Multivariate Correlation between Major Phenolic classes and *in vitro* Antioxidant Activity of Brazilian Red Wines.
Daniel Granato, Flávia Chizuko Uchida Katayama, Inar Alves Castro, University of São Paulo, São Paulo, São Paulo, Brazil

Red wine consumption has been associated with protection from damaging oxidation reactions caused by free radicals due to their phenolic composition. Our objective was to evaluate the association among chemical parameters, the commercial value, and the antioxidant activity of Brazilian red wines. Twenty-nine samples from five different varieties were assessed. Samples were separated into three groups using cluster analysis: cluster 1 presented the highest antioxidant activity towards DPPH (68.51% of inhibition) and ORAC (30,918.64 μM Trolox Equivalents), followed by cluster 3 (DPPH = 59.36% of inhibition; OARC = 25,255.02 μM Trolox Equivalents) and then cluster 2 (DPPH = 46.67% of inhibition; ORAC = 19,395.74 μM Trolox Equivalents). Although the correlation between the commercial value and the antioxidant activity on DPPH and ORAC was not statistically significant (P = 0.13 and P = 0.06), cluster 1 grouped the samples with higher commercial values. Cluster analysis applied to the variables suggested that non-anthocyanin flavonoids were the main phenolic class exerting antioxidant activity on the samples.

Identification of Soy Protein-derived Hypolipidemic Peptide-sequences Using in vitro and in vivo System.
Koji Nagao[1], Nao Inoue[1], Kotaro Sakata[1], Naomi Yamano[1], Pathma Gunawardena[1], Toshiro Matsui[2], Toshihiro Nakamori[3], Hitoshi Furuta[3], Kiyoharu Tkamatsu[3], Teruyoshi Yanagita[1], [1]Saga University, Saga 840-8502, Japan, [2]Kyushu University, Fukuoka 812-8581, Japan, [3]Fuji Oil Co. Ltd., Osaka 598-8540, Japan

Soy protein is one of the vegetable proteins examined extensively for lipid lowering effect in humans and in experimental animals. Although soy protein isolate contains certain amount of bioactive peptides which have distinct physiological activities in lipid metabolism, it is not clear that which peptides are responsible for these effects. In the present study we have investigated the effect of soy protein-derived peptides on lipid metabolism in HepG2 cells and obese OLETF rats. In previous experiments, we found that soy crude protein (SCP-LD3) and hydrophilic peptides (separated from SCP-LD3 with hydrophobic synthetic absorbent) revealed lipid lowering effect in HepG2 cells and in OLETF rats. Moreover, we found that F4 peptides (fractionated from hydrophilic peptides by GPC-HPLC) and 0% CH3CN/0.1% TFA-fraction (isolated from F4 peptides by ODS column chromatography) revealed hypolipidemic effects in HepG2 cells. In the present study, we found that three di-peptides reduced TG synthesis and one di-peptide reduced apoB secretion in HepG2 cells. In conclusion, we could have isolated active di-peptide sequences of lipid lowering effects from soy protein.

Antioxidant Capacity and Lipid Characterization of Six Georgia-grown Pomegranate Cultivars.
G. Pande, C.C. Akoh, Dept. of Food Science & Technology, University of Georgia, Athens, GA, USA

Six Georgia-grown pomegranate (Punica granatum) cultivars were analyzed for their antioxidant capacity and lipid profile. Total polyphenols (TPP) were determined by Folin Ciocalteau method. Major organic acids and phenolic compounds were analyzed by RP-HPLC and punicalagin isomers were identified by MS-ESI. Two antioxidant assays, ferric reducing antioxidant power (FRAP) and trolox equivalent antioxidant capacity (TEAC), were used to assess antioxidant capacity. Tocopherols and phospholipids were identified and quantified by NP-HPLC using fluorescence detector for tocopherols and evaporative light scattering detector (ELSD) for phospholipid analysis. Phytosterols and fatty acid profile were analyzed by GC. GC-MS was used to identify punicic acid. The predominant organic acid was citric acid followed by malic acid. Peel fraction had the highest total hydrolyzable tannins content (4792.3-6894.8 mg/100 g FW). Overall, the highest antioxidant capacity was found in leaves followed by peel, pulp, and seed. Pomegranate seed had an average total lipid content of 19.2% with punicic acid being the major fatty acid (78.3-83.4%). Pomegranate seed had high content of α- tocopherol (161.2-170.1 mg/100 g) and γ-tocopherol (80.2-92.8 mg/100 g).

Influence of Soybean, Olive, Macadamia Nut, and Fish Oils on Hepatic Fatty Acid Metabolism in Mice.
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De novo hepatic lipogenesis (DNL) occurs as a result of dietary carbohydrate excess. This causes hepatic fat accumulation and may lead to chronic inflammation, cirrhosis, and liver failure. Recently, fish oil has been shown to limit DNL while soy bean oils have been shown to enhance DNL during administration of TPN containing glucose and amino acids. However, the effect of other oils upon DNL is unclear. We hypothesized that oils rich in n-3 PUFAs or n-7 and n-9 MUFAs would be equally effective in reducing DNL and that oils high in n-6 PUFAs would enhance DNL. Mice were fed isonitrogenous and isocaloric diets high in sucrose or fructose. Both diets enhanced hepatic synthesis of saturated and monounsaturated fatty acids and resulted in the accumulation of lipid droplets in liver. Concomitant administration of Soybean, Olive, Macadamia Nut, and Fish Oil-based lipid emulsions through the gastric route inhibited fatty acid synthesis and fat accumulation in rat liver in a similar fashion. Stearoyl CoA desaturase activity (SCD) was stimulated with sucrose and fructose feeding. All emulsions inhibited SCD activity in a similar fashion. In conclusion, co-administration of dietary lipids containing unsaturated fatty acids with carbohydrates may represent an approach for limiting hepatic lipogenesis and its health consequences.

Effects of Diets Containing Fish Oil on Fatty Acid Composition of Jade Tiger Hybrid Abalone.
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Seafood including abalone are good source of n-3 long chain (LC) PUFA. The aim of the present study was to investigate the effects of feed supplemented with fish oil (FO) on fatty acid (FA) composition in muscle of Jade tiger abalone. Six diets were prepared to vary in the percentage inclusion of lipid as follows: diet 1, control (contained no lipid supplement); diet 2, 0.5%; diet 3, 1.0%; diet 4, 1.5%; diet 5, 2.0%; and diet 6, 2.5%. FO was used as lipid sources. The abalone were fed the experimental diets for 12 weeks. The lipids were extracted by chloroform-methanol (2:1, v/v). Total lipid content was measured gravimetrically and the FA composition was analysed by GLC. The results showed that EPA, DHA and total n-3 PUFA levels in muscle, fed diet 4 were significantly higher compared with the abalone fed the other diets ($p<0.01$). The lowest levels of these FAs were found in abalone fed the control diet ($p<0.01$). In conclusion, addition of FO to normal artificial diet can improve n-3 LC PUFA levels of cultured abalone.

Modulation of Lipid Droplet (LD) Formation and Cell Proliferation by Wy14643 in Response to Conjugated Linoleic Acid (CLA).
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Aim: To determine how the Peroxisome Proliferator Activated Receptor-alpha (PPARa) agonist, Wy14643, affects LD

formation, cell proliferation and hepatic markers of fatty acid (FA) transport, oxidation and synthesis in H4IIE hepatoma cells in response to treatment with the cis-9,trans-10 and trans-10,cis-12CLA isomers.Methods: Cells were treated for 10 min with 250 µM Wy14643 and subsequently exposed to individual CLA isomers (60 µM) for 24 hours. Cell proliferation and viability were assessed with Cell counting kit-8 (CCK-8). LDs were stained and quantified with Oil RedO. Relative protein levels were determined by immunoblotting in relation to a loading control.Results: Compared to vehicle controls, incubation of H4IIE cells with CLA induced LD formation and up-regulated Liver-FA-binding protein, Acyl CoA Oxidase and Proliferating Cell Nuclear Antigen levels in a time and dose-dependent manner. In contrast, concomitant addition of Wy14643 reduced the formation of LD in response to CLA. CCK-8 results showed reduced cell viability in CLA-treated cells compared to Wy14643. Importantly, this effect was more pronounced in growing cells than in quiescent ones.Conclusion: Wy14643 reduces LD formation in H4IIE cells treated with CLA indicating that PPARa may effectively modulate fatty acid metabolism in conditions with elevated FAs such as obesity and steatosis.

Oxidation of Flax Oil Cyclolinopeptides (CLP): Preparation of CLP-J and -K.
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Cyclolinopeptides present in flax seed oil are known to exhibit various biological activities including immunosuppression and induction of apoptosis in human epithelial cancer cell lines. To date, nine cyclolinopeptides (CLP-A to I), having molecular weights of approximately 1 kDa have been isolated from flax oil. NMR analysis of these CLPs can help in determining the 3D structures which may, in turn, provide a better understanding of the mechanism(s) of biological activity. Cyclolinopeptides C [cyclo(-Pro-Pro-Phe-Phe-Val-Ile-Mso-Leu-Ile-)] and CLP-E [cyclo(-Pro-Leu-Phe-Ile-Mso-Leu-Val-Phe-)] each possess one methionine sulfoxide (Mso) in their side chains. These Mso groups are prone to oxidation on silica gel when stored for long periods of time. The known oxidation products are CLP-K [cyclo(-Pro-Pro-Phe-Phe-Val-Ile-Msn-Leu-Ile-)] and CLP-J [cyclo(-Pro-Leu-Phe-Ile-Msn-Leu-Val-Phe-)], respectively, each containing a methyl sulphone (Msn) group. These compounds were isolated in multi-gram scale and were characterized with extensive 2D NMR methods: 1H-1H COSY, HSQC, NOESY, and HMBC. The three dimensional structure and biological activity will be discussed.

The Bioactive Cyclic Peptides in Flax.
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Cyclolinopeptides (CLPs) are hydrophobic peptides found in flax products including flax seed and oil. They are known to exhibit strong immunosuppressive activity. Quantitative analysis of the distribution of CLPs in flax seeds and the levels of CLPs in different commercial flaxseed oils was conducted. Purification of CLP-A, CLP-C, and CLP-E using preparative chromatographic techniques was achieved and enabled the biological activities of each CLP to be tested. It was found that CLP-A enhanced the expression of heat shock protein 70A and induced mortality in nematodes. CLP-A, CLP-C, and CLP-E were also observed to modulate the expression of apoptosis marker genes (P21, PUMA and BCL-2) causing the induction of apoptosis in a human lung epithelial cancer line. In microarray analysis, the expression of genes involved in the regulation of apoptosis in human lung adenocarcinoma cells, such as BAK, CDEB, FASLG, TNF, etc., were tested and the results showed CLP-A, CLP-C, and CLP-E affected the regulation of many pro and anti-apoptotic genes. It was concluded that CLPs are potential drug like molecules in terms of biological activity and adsorption.

Macular Pigment Optical Density During Pregnancy and its Relationship to the Diet.
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The eye′s macular pigment is composed of carotenoids, lutein (L) and zeaxanthin (Z), and docosahexanoic acid (DHA, 22:6n-3) may increase macular pigment optical density (MPOD). Women are at higher risk for age-related macular degeneration (AMD) than men and higher levels of MPOD may protect against AMD. To date, MPOD for pregnant women has not been reported; however, DHA is preferentially transferred across the placenta and we posed the question: ′Does pregnancy increase risk for decreased MPOD and therefore AMD?′ MPOD was measured for 22 women using a macularmetrics densitometer (18-23, 24-26, 30, 36-38 weeks of pregnancy) and dietary information was collected using repeated food frequency questionnaires and 24-hour dietary recalls. Based on this small sample,

results point to no change in MPOD during pregnancy (LSM ± SE: 0.34 ± 0.04, 0.34 ± 0.03, 0.33 ± 0.04, 0.28 ± 0.04). However, MPOD was positively correlated with the consumption of fruits and vegetables high in L&Z (p-value<0.02) and weekly seafood intake (p-value<0.01). In conclusion, MPOD is significantly higher among pregnant women with diets rich in L and Z and seafood; a larger sample size will be needed to conclude if pregnancy is a risk factor for decreased MPOD.

Fucoxanthin Regulates Adipocytokine mRNA Expression in White Adipose Tissue of Diabetic/Obese Mice.
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Fucoxanthin, a marine carotenoid found in edible brown seaweeds, attenuates white adipose tissue (WAT) weight gain and hyperglycemia in diabetic/obese KK-Ay mice, although it does not affect these parameters in lean C57BL/6J mice. Adipocyte size in mesenteric WAT of KK- Ay mice fed fucoxanthin was also smaller than those of control mice after 2 weeks feeding. Fucoxanthin markedly decreased mRNA expression levels of monocyte chemoattractant protein-1 (MCP-1) and tumor necrosis factor-α (TNF- α), which are considered to induce insulin resistance in WAT of KK-Ay mice. Compared with KK-Ay mice, fucoxanthin did not alter MCP-1 and TNF-α mRNA expression levels in the WAT of lean C57BL/6J mice. Interleukin-6 (IL-6) and plasminogen activator inhibitor-1 mRNA expression levels in WAT were also decreased by fucoxanthin in KK-Ay mice. In differentiating 3T3-F442A adipocytes, fucoxanthinol, which is a fucoxanthin metabolite found in WAT, attenuated TNF-α-induced MCP-1 and IL-6 mRNA overexpression and protein secretion in the cultured medium. In addition, fucoxanthinol decreased TNF-α mRNA expression in RAW264.7 macrophage-like cells stimulated by palmitic acid. These findings indicate that fucoxanthin regulates mRNA expression of inflammatory adipocytokines involved in insulin resistance in WAT, and has specific effects on diabetic/obese KK-Ay mice, but not on lean C57BL/6J mice.

The Supply of Naturally Sourced Plant Seed Oils Containing Stearidonic Acid?A Decade of Multidisciplinary Research.
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Technical Program