Phospholipid Interest Area
Technical Program Abstracts

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PHO 1: General Phospholipids

Chairs: B. Sebree, Archer Daniels Midland Co., USA; and M. Rebmann, Perimondo, USA

Physicochemical Stability of Chia Seed Oil Bi-layer Emulsions. L.M. Julio[1], V.Y. Ixtaina[1], S.M. Nolasco[2], and M.C. Tomás*[1], [1]Centro de Investigación y Desarrollo en Criotecnología de Alimentos (UNLP, CONICET), Argentina, [2]TECSE (Facultad de Ingenieria, UNCPBA), Argentina.

The development of multilayer emulsions with chia oil is very interesting since this oil is sensitive to lipid oxidation due to its high omega-3 content. This emerging method based on the electrostatic layer-by-layer deposition provides interfacial layers of greater thickness around the oil improving its stability. A primary (lecithin, Lec) and secondary emulsion (Lec+chitosan) was prepared by homogenizing 5% wt chia oil with 95% wt aqueous solution (600 bar), pH3, stored ~1 month at 4.0±0.5°C. Emulsions were evaluated by confocal microscopy, ?-potential, apparent viscosity and the evolution of backscattering profiles, particle size distribution, mean diameter (D[4,3]) and peroxide value (PV). Surface charge changed from -37 to 46 mV when chitosan was added. The particle size distribution was monomodal for the two-layer emulsions, whereas the mono-layer emulsions presented a little shoulder. The initial D[3,2] was 0.32µm and 0.26µm for mono and bi-layer emulsions, respectively. Mono-layer emulsions recorded some signs of destabilization after 20 days of storage, while bi-layer emulsions were physically stable during this period. As determined by PV, bi-layer systems of Lec and chitosan were more stable than those with Lec alone. These data suggest that multilayer emulsion could be an effective technology to deliver chia oil into functional foods.

The Impact of Crude Soybean Oil Quality on Enzymatic Degumming Efficiency. F. Cong[1], L. Yu[2], Y.R. Jiang[1], and X.G. Wang[2], [1]Wilmar (Shanghai) R&D Center, China, [2]Jiangnan University, China.

Despite over 20 years development of enzymatic degumming, this technique is still not fully adopted in soybean oil industry. The main reason is the unstable performance on crude oils with different quality. To study the impact of crude oil quality on enzymatic degumming efficiency, we collected 29 types of oil manufactured by different factories, with the seeds originated from USA, Argentina, Brazil and China. We detected the composition of phospholipids (NMR) and metal ion content (ICP-MS) of these oils, and carried out PLC and PLA1 degumming. We found bivalent metal ion content is significantly correlated with the PA content, suggesting they are associated in seeds and co-extracted to crude oil. The phosphorous contents of PLA1 degummed oil without acid treatment is significantly correlated with the amount of metal ions and the ratio of PA to PC and PI. Once using citric acid pretreatment, metal ion has no impact, but the ratio of PA to PC and PI still has impact. Inspired by this result, we added hydratable PL to crude oil to assist degumming and phosphorus contents is obviously declined. For PLC degumming efficiency, besides PC and PE, PA also has relativity to the increase of DAG. PA has negative influence on the ratio of the actual to the theoretical increment of DAG, suggesting PA is not only itself unreacted, but also prevent PC and PE getting hydrolyzed by PLC.

Selective and Accurate LC-MS/MS Method for Determination of Choline and Ethanolamine Plasmalogen Molecular Species in Human Plasma. Y. Otoki[1,3], S. Kato[2], F. Kimura[1], K. Furukawa[1], H. Arai[1], A. Taha[3], W. Swardfager[4], K. Nakagawa[1], and T. Miyazawa[1], [1]Tohoku University, Japan, [2]Nippon Medical School, Japan, [3]University of California, Davis, USA, [4]University of Toronto, Canada.

Plasmalogen (Pls) is a physiologically important class of vinyl ether-linked phospholipid. Recently, patients suffering from neurodegenerative disorders have been reported to exhibit reduced levels of choline Pls (PC-Pls) and ethanolamine Pls (PE-Pls) in blood plasma. However, information on the Pls molecular species affected is rarely available due to the low fragmentation of Pls, particularly PC-Pls, when using liquid chromatography coupled with tandem mass spectrometry (LC-MS/MS). Quantitative issues (e.g., extraction recovery and matrix effects) remain to be resolved. In the present study, we aimed to develop an accurate identification and quantification method of Pls molecular species using LC-MS/MS. First, by MS/MS analysis it was shown that both PC- and PE-Pls yielded specific product ions in the presence of sodium. Then using the product ion, we determined predominant PC-Pls and PE-Pls molecular species in the methanol extract of plasma from subjects with Alzheimer's disease and major depressive disorder. Under the present conditions, extraction recoveries of Pls species from plasma were nearly 100%, and matrix effects were not observed. The method developed herein appears to be a powerful tool for analyzing Pls and may provide a better understanding of their physiological roles *in vivo*.

Validated Analysis of Phospholipid in Infant Nutrition Using Univariate and Multivariate Modelling of ^{1}H and ^{31}P NMR Spectra. Y.B. Monakhova, M. Betzgen, and B.W.K. Diehl, Spectral Service, Germany.

^{1}H and ^{31}P NMR methods were validated according to the good laboratory practice principles to control a number of phospholipids (PL): PC, 2-LPC, PS, SPH, DSPH, PE, LPE and PI in infant nutrition. A ^{31}P NMR method, being highly selective regarding the number of detected PL species, requires Soxhlet extraction, which sometimes fails due to hydrolisation. Extraction procedure was therefore optimized to avoid overheating of the sample solution. ^{1}H NMR method, which requires less sample amount and no Soxhlet extraction, was found to be suitable for the simultaneous qualitative

measurement of PC, SPH, PE, and PI. For this simple method the limits of detection and limits of quantification varied in the 0.0014-0.0290mg and in the 0.00295-0.059mg range for 300mg sample weight, respectively. The coefficients of variation for intraday and interday repeatability did not exceed 3.0% for PC and SPH and 10% for PE and PI. ^{1}H NMR spectra showed good linearity for the 150-450mg sample weight (R^2>0.99) and recovery rates between 97.7% and 107.2% on average. Along with standard integration procedure, Lorenz deconvolution, partial least squares and independent components analysis were successfully applied to extract PL signals from overlapping NMR spectroscopic profiles and additional quantification of PS species.

PHO 2: Bioactive Phospholipids

Chairs: E.M. Hernandez, Advanced Lipid Consultants, USA; and M. Torres-Gonzalez, Dairy Research Inst., USA

Daily Stress Management with Nutritional Bio-active Phospholipids. D. Rutenberg, Lipogen Ltd., Israel.

Supplementation of diet with Bio-Active Specialty Phospholipids, particularly phosphatidylserine + phosphatidic acid complex (PAS) has been observed to very effectively normalize stress induced levels.

The most recent findings indicates substantial positive effects of an oral supplementation with 400mg PS & 400mg PA (PAS 400) per day on the endocrine stress response (ACTH, saliva and serum cortisol) to a psychosocial stressor.

Methods: 75 healthy male volunteers were enrolled for this double-blind, placebo-controlled study, stratified by chronic stress level, and randomly allocated to one of three study arms (placebo, PAS 200 and PAS 400 per day, respectively). Study supplementation was administered for 42 days for each participant. Chronic stress was measured with the Trier Inventory for Chronic Stress (TICS), and subgroups of high and low chronic stress were differentiated by median values as provided by the TICS authors. A six week period of supplementation was followed by an acute stress test (Trier Social Stress Test - TSST).

Conclusion: For chronically stressed subjects, a daily supplementation with PAS 400 (MemreePlus™) can normalize the hyper-responsivity of the HPAA to an acute stressor.

Dairy Bioactive Phospholipids: Composition, Properties, Nutritional Aspects, and Application for Delivery Systems. B. Farhang and M. Corredig, Gay Lea Foods Co-operative, Canada.

The phospholipid and sphingolipid composition of milk is of considerable interest, mostly because these components can impart unique nutritional and functional properties to foods when used as ingredients. These polar lipids are present in the milk fat globule membrane (MFGM), which is a complex mixture of glycolipids, phospholipids and proteins. The phospholipids are known to positively influence brain and cognitive development in the neonate. Phospholipids fractions from milk are now commercially available. The phospholipid fractions isolated from bovine milk have a profile that is very similar to that of human milk as well as neural tissues. Milk phospholipids are suitable for formulating a range of health foods targeting brain health and cognitive benefits in infant's children, adults and seniors. MFGM fractions also possess several advantages over other sources of phospholipids; In vivo studies show that MFGM fractions enhance intestinal drug absorption, suggesting that there will be opportunities in the future for use of MFGM For bioactive delivery. MFGM has also been shown to have antiproliferative properties on intestinal cancer cells. In this presentation, milk phospholipids composition, their health benefits and application for bioactive delivery will be reviewed. Possible effects of processing history on their functionality will also be discussed.

Bioactive Structured Phospholipids: Roles in Pharma, Health, and Nutrition. E.M. Hernandez, Advanced Lipid Consultants, USA.

Phospholipids generally have a bipolar, amphiphilic molecular structure with a tendency to form bilayers, micelles, niosomes and liposomes. As a result they find many applications in food, cosmetic and pharmaceutical products as natural emulsifiers, wetting, dispersing and, just as important, bioactive agents. Phospholipids also play a significant role in cell structure and functions.

Bioactive structured phospholipids can be synthesized using phospholipases (A1, A2, C, and D) and lipases. These enzymatically catalyzed reactions can be conducted using immobilized phospholipases and combination with lipases to produce phospholipids with specific bioactive properties. This paper will review techniques on synthesis and applications of bioactive structured phospholipids such as enzymatically enriched PLs with n-3 fatty acids (Linolenic, EPA, and DHA), CLA, omega 7 fatty acids as well as the and synthesis and applications of phospholipids containing bioactive sterols catalyzed with phospholipase D .

Properties of Omega-3 Phosphatidylcholine. N. Hoem, Aker BioMarine, Norway.

Krill "oil" from a technical point of view is better classified as "krill lecithin". This talk will present data on the compositional and chemical specifics of krill and on the phospholipids, predominantly phosphatidylcholine (PC) and lyso-phosphatidylcholine found in krill oil. Data will also be presented linking such data in krill oil to lipids found in Antarctic krill. Since the major part of PC in krill oil contains either EPA or DHA, investigation of preclinical and clinical effects of krill oil have indirectly shed light on biological effects of such omega-3 phospholipids (O3PL). Data will also be presented comparing the uptake and distribution of such O3PL with omega-3 fatty acids in triglyceride form. Additionally, general data and results will be presented from preclinical as well as clinical research on krill oil and/or purified O3PL.

Bioactive Properties of Egg-derived Lecithin. D. Aguilar-Alvarez, Dept. of Athletic Training & Nutrition, Weber State University, USA.

Phospholipids (PL) from eggs account for up to 40% of the US phospholipid consumption. Around 28% of lipids found in eggs lipid are PLs, with Phosphatidylcholine (PC), phosphatidylethanolamine (PE), sphingomyelin (SM), and phosphatidylinositol (PI) being the most predominant species. This overview will cover egg PL's main health effects. Examples include multiple studies which utilized egg yolk

purified PLs and found an association between the high content of docosahexaenoic acid (DHA) in these lipids and improved cognitive function. Recent cell studies have shown that egg PLs were able to interfere with tumor progression. Furthermore, egg PL have been shown to modulate systemic and gastrointestinal track inflammation. Nevertheless, the most well documented effects of egg PL are their cardioprotective effects. Studies suggest that egg PLs decrease dietary cholesterol absorption, induce and promote reverse cholesterol transport, and regulate and modulate cholesterol and lipid synthesis in the liver. The benefits associated with egg PL consumption are promising and warrant further investigation.

PHO 3/H&N 3.1: Delivery Systems

This session developed in conjunction with the Health and Nutrition Division.

This session sponsored in part by Johnson & Johnson Consumer Inc.

Chairs: M. Rebmann, Perimondo, USA; and K. Mahmood, Johnson & Johnson Consumer Inc., USA

Topical Delivery Enhancement of Actives into Skin by Lipid Based Vesicular Systems. J. Paturi, Johnson & Johnson Consumer Inc., USA.

Delivering actives into skin is challenging due to resistance offered by the stratum corneum. A wide variety of enhancement techniques continue to evolve to address this challenge ranging from simple solvents acting as penetration enhancers to the more complicated nanoparticles. Developing a delivery system which can incorporate small as well as large molecules irrespective of their polarity is important to enhance penetration across biological membranes. Liposomes are vesicular systems with the ability to encapsulate both hydrophilic and lipophilic actives and enhance their topical penetration profiles. Ample studies have already established this with phospholipid based liposomes. This talk focusses on non-phospholipid vesicular systems and their characterization. It also provides insights into delivering actives *in vitro* through these vesicular systems for skin benefits.

***In vitro* Digestibility and Bioaccessibility of Lipid-based Delivery Systems Obtained via Enzymatic Glycerolysis: A Case Study of Rosemary Extract Bioactivity.** M. Corzo-Martínez[1], T. Vargas[1], L. Vázquez[2], G. Reglero[1,2], A. Ramírez de Molina[1], and C.F. Torres[2], [1]Inst. of Food Science Research, CIAL (CSIC-UAM), Spain, [2]IMDEA-Food Inst. CEI (UAM-CSIC), Spain.

Association to lipid-based delivery systems (LDS) is a formulation strategy usually used for improving bioaccessibility and, hence, efficacy *in vivo* of bioactive compounds. In this sense and attending to the multiple biological activities of alkylglycerols (AKG), their utilization as LDS provides additional interest. However, AKG show poor digestibility which limits their applicability. This highlights the importance of the development of effective lipid formulation strategies.

The aim of this work was to study the effect of enzymatic glycerolysis on digestibility of ratfish liver oil rich in AKG, as well as the glycerolysis product capability as LDS. For that, it was combined with a rosemary extract and bioaccessibility and bioactivity of the formulations was assessed. An *in vitro* intestinal digestion model simulating *in vivo* conditions was used for digestibility and bioaccessibility studies and antiproliferative activity was determined using human pancreatic cancer cells.

The glycerolysis product showed higher digestibility than the original oil. The combination of rosemary extract with this product improved its bioaccessibility.

Enzymatic glycerolysis is, therefore, an efficient formulation strategy leading to more bioaccessible and bioactive LDS which could be used to design effective functional foods.

Increasing Bioavailability of Lipophilic Nutraceuticals: The Effects of Mixed Micelles. J. Chen[1,2], F. Li[1], D.J. McClements[1], and H. Xiao[1], [1]University of Massachusetts Amherst, USA, [2]State Key Lab. of Food Science & Technology, Jiangnan University, China.

Poor bioavailability of lipophilic nutraceuticals negatively affects their health-promoting efficacy. Polmethoxyflavones (PMFs) is a group of lipophilic nutraceuticals with many beneficial activities. In this study, we investigated the effects of mixed micelles in the intestinal uptake of PMFs. Mixed micelles from canola oil and olive oil were obtained by *in vitro* digestion of canola oil and olive oil-based nanoemulsions, respectively. 5, 3', 4',-Tridemethylnobiletin (THN, a representative PMF) was then dispersed in the micelles. The micelles were then added to culture media and incubated with intestinal epithelial cell (Caco-2) growing on glass slides. At different incubation times, the cells were fixed and stained with 2-Aminoethyl diphenylborinate (DPBA). Our results showed when excited by laser with certain wavelength, the DPBA and THN conjugate were fluorescent. The cells were observed under a fluorescent microscope. In the mean time, micelles-treated cells were also harvested, processed, and analyzed with flow cytometer. Results from both fluorescent microscope and flow cytometer analysis showed that mixed micelles significantly increase cellular uptake of THN. This study is the first to use DPBA to monitor the intestinal cellular uptake of PMF, and to show the potential of mixed micelles in enhancing cellular uptake of PMF.

Characterization of Intestinal Digestion of Ceramide 2-aminoethylphosphonate, a Marine Sphingolipid. N. Tomonaga, D. Qi, Y. Manabe, and T. Sugawara, Div. of Applied Biosciences, Graduate School of Agriculture, Kyoto University, Japan.

Ceramide 2-aminoethylphosphonate (CAEP) is one of the major sphingolipids of marine origin and generally contained in Mollusca, such as squid and shellfish consumed around the world. CAEP has unique structures such as a phosphorus-carbon bond in the polar head and triene type of sphingoid bases. Notwithstanding, it is known that some dietary sphingolipids are digested and absorbed in the intestinal tract, there is no information about CAEP. To investigate the efficacy of dietary CAEP, we examined its digestion in the intestine of mice.

CAEP was extracted and purified from the skin of jumbo flying squid Dosidicus gigas. CAEP was incubated with homogenate of small intestinal mucosa of mouse. Ceramides

and free sphingoid bases which are the degradation products from CAEP were determined by LC-MS.

We found that intestinal mucosa can remarkably hydrolyze CAEP to ceramides and sphingoid bases. Our results suggest that dietary CAEP is probably hydrolyzed in digestive tract and generated sphingoid bases may be absorbed from intestinal epithelial cells, similar to other dietary sphingolipids.

Improved Stabilisation of Concentrated Oil-in-Water Emulsions by Complexing Soy Protein with κ-carrageenan. I. Tavernier[1], P. Van der Meeren[2], K. Dewettinck[1], and A.R. Patel[1], [1]Lab. of Food Technology & Engineering, Ghent University, Belgium, [2]Particle & Interfacial Technology Group, Dept. of Applied Analytical & Physical Chemistry, Belgium.

Biopolymers such as hydrophilic proteins are commonly used stabilizers in O/W emulsions. However, for the development of highly concentrated emulsions ($\phi_{oil} \geq 0.6$), the stabilization provided by only proteins is often insufficient. The emulsion stabilizing properties of proteins can markedly be enhanced by complexing them with suitable polysaccharides. In this work, we report for the first time the use of soy protein isolate – κ-carrageenan (SPI:κ-CG) complexes as stabilizing agents for concentrated oil-in-water emulsions prepared at $\phi_{oil} = 0.6$.

The colloidal stability of concentrated emulsions stabilized with SPI was compared to emulsions stabilized by SPI:κ-CG complexes using advanced microscopy and light scattering experiments. These measurements showed that a better long-term stability was achieved by using the SPI:κ-CG complexes compared to using only SPI. Rheological studies revealed that the stability enhancement effect was due to interfacial accumulation of particles rather than the increase in the bulk viscosity. Cryo-SEM analysis and Confocal Scanning Laser Microscopy of the emulsions confirmed the formation of SPI:κ-CG particles and visualized their interfacial accumulation.

The potential of using SPI:κ-CG complexes as stabilizers for concentrated emulsions could open up new opportunities for the development of emulsifier-free food products.

Interfacial Behavior of Milk Polar Lipids and Their Influence on Gastric Lipase Adsorption: A Natural Effective Delivery System. C. Bourlieu[1,4], W. Mahdoueni[1], G. Paboeuf[2], S. De Oliveira[1], S. Pezennec[1], J.F. Cavalier[3], S. Bouhallab[1], D. Dupont[1], P. Villeneuve[4], F. Carrière[3], and V. Vié*[2], [1]INRA-AGROCAMPUS, France, [2]IPR Inst. of Physics, Rennes University, France, [3]CNRS, Aix-Marseille Université, France, [4]CIRAD, UMR IATE, France.

The polar lipids in human milk fat globule membranes condition the accessibility and enzymatic digestibility of milk lipids. Their substitution by bovine polar lipids to produce infant formulas biomimetic of human milk has been suggested. However a comparison of the interfacial behavior of bovine and human polar lipids and of their interaction with gastric lipase is lacking.

Such comparison is here undertaken using complementary biophysical tools: tensiometry, ellipsometry, Brewster angle and atomic force microscopy, in the presence or in the absence of gastric lipase. Polar lipids extracts were obtained from a pool of human milk (n=5) or bovine butterserum and analyzed using GC and HPLC.

Human milk polar lipids (HMPL) had a higher compressibility than bovine milk polar lipids (BMPL). Despite the presence of liquid condensed domains in both extracts, their morphological aspect and growth differed in relation with the lipid composition. Lipid phase separation impacted on gastric lipase adsorption in both extracts with an exclusive adsorption onto the liquid expanded phase. Despite differences in their physico-chemical properties, both polar lipid extracts share close interfacial reactivity in gastric conditions. This biophysical characterization will be broadened to other milk polar lipids interesting for human milk substitution.

PHO 4: Synthetic Phospholipids and Fatty Acids

Chairs: M.U. Ahmad, Jina Pharmaceuticals Inc., USA; and S.R. Jadhav, ADM Research, USA

Enzymatic Synthesis of Sugar and Polyol-fatty Acid Esters: Surfactants, Polymers, and Other Value-added Products. D.G. Hayes, University of Tennessee, USA.

Applied biocatalysis in nonaqueous media has come a long way since its inception in the 1980s, when I conducted my PhD Dissertation project in this new and emerging area. Bioconversions using immobililzed enzymes are commonly employed today, particularly in the custom design of lipids, to take advantage of the high selectivity of biocatalysts and to increase the "greenness" of manufacturing: near-ambient operating conditions, lower downstream purification costs and waste generation, among other advantages. In this presentation, I will provide a review of the lipase-catalyzed synthesis of sugar-fatty acid esters, important biodegradable and biocompatible surfactants commonly used as emulsifiers (which also possess high bioactivity). The reaction is challenging to implement due to the diverse polarities (hence poor miscibility) of the starting materials. The review will include topics such as solvent selection (including the use of ionic liquids as novel versatile solvents), or alternatively, solvent-free conditions, water activity control, bioreactor design, and selection and/or derivatization of the starting materials, and will feature research work from my lab and from other groups.

Towards the Generation of Highly Occlusive Materials: Synthesis and Evaluation of Ultra-long Chain Omega Acylated Fatty Acids. B.C. Pérez[1], S. Emil[1], P. Bulsara[2], A.V. Rawlings[3], M.M. Jensen[4], M. Glasius[4], M. Dong[5], M. Clarke[2], and Z. Guo*[1], [1]Dept. of Engineering, Aarhus University, Denmark, [2]New Product Research, GlaxoSmithKline Consumer Healthcare, USA, [3]AVR Consulting Ltd., UK, [4]Dept. of Chemistry, Aarhus University, Denmark, [5]Interdisciplinary Nanoscience Center, Aarhus University, Denmark.

The stratum corneum (SC), the outmost layer of the skin, protects the dermis from environmental agents and chemical assaults and regulates the water loss from the body. The SC is often described as a "brick" and "mortar" structure where the corneocytes represent the bricks and the lipids the mortar that hold the corneocytes together. In the search for SC lipids analogues that help prevent transepidermal water loss (TEWL) which can lead to xerotic skin condition; a series of ultra-long chain omega acylated fatty acids (ULFA) of up to 34 carbon chain were designed, synthesized, and evaluated as potential occlusive ingredients for skin care formulations. Based on DSC, FTIR, and Langmuir monolayer studies, synthesized ULFA could be classified in three groups: i) Symmetric ULFA with omega-hydroxy fatty acid chain of same side as the fatty acyl chain; ii) ULFA with longer omega-hydroxy fatty acid; and ii) ULFA with longer fatty acyl chain. Moreover, results showed that highly asymmetric ULFA promoted tighter packing behavior. Accordingly, the most promising ULFA were evaluated through Water Vapor Transmission Rate measurements. Although synthesized compounds displayed slightly occlusive features by WVTR, overall results demonstrated ULFA to be promising building blocks to generate occlusive agents.

Amino Acyl Glycerols: Preparation and Evaluation of Surface Activity and Antimicrobial Properties. M. Ghosh and S. Chakraborty, University of Calcutta, India.

Foods are now designed to cater all the requirements to improve the nutritional score with the combination of various nutrients. So that, beyond adequate nutritional qualities they already have, they can also be effective for one or more improved body functions.

Amino acids and mono-glycerides are widely used as emulsifiers in the food formulation and constitute an interesting class of surfactants with good surface properties. These surfactants, entirely composed of natural food-grade ingredients, may control lipid digestion and release and possesses low potential toxicity and high biodegradability. Moreover, they can be synthesized using selective chemo enzymatic methods from natural renewable sources of raw materials such as amino acids and fatty acids. The critical combination of these two main components produce a novel class of amino acid lipid conjugate with effective surface active properties which can be utilised by the food industries. The physicochemical and biological properties of amino acid glyceride conjugates are yet to be explored. The present study aims to obtain amino acyl glycerol types of compound with improved and distinct physical properties different from raw materials and evaluation of their surface activity and antimicrobial properties.

Synthesis of Erythritol Fatty Acids by Lipase and Their Properties Evaluation. Y. Zheng, X. Xu*, and T.K. Yang, Wilmar (Shanghai) Biotechnology Research & Development Center Co., Ltd., China.

Erythritol is a sugar alcohol with a carbon number of 4 and is a naturally occurring sweetener. Recently, it is of growing particular interest because of its cooling feeling, low calorie, and biological activities. Nevertheless, to our knowledge, there are few reports on the modification of erythritol alcohol to produce erythritol fatty acid esters. Utilization of enzymes as biocatalysts for preparing sugarfatty acid esters has attracted great attention because of growing consumer demand for green processes and products. On the other hand, the enzymatic process will bring the advantage of the high specificity of the reaction at a lower temperature and an easier downstream process, which will generate various products with controlled structure and functionality.

In this present study, a series of di- and tri- erythritol

fatty acid esters were catalyzed by lipase. The effects of reaction parameters, including source of enzyme, organic solvent, substrate molar ratio, and water content on the conversion and distribution of di- and tri- erythritol fatty acid esters were investigated. In addition, the emulsifying property and antimicrobial ability of these esters were evaluated. The result shows that both di- and tri- erythritol fatty acid esters can be used as a potential emulsifier and antimicrobial agent.

Trihydroxy Fatty Acids as Novel Biological Fungicides in the Crop and Food Industries. F. Schultz[1,2], Z. Sadykova[2], J. Caesar[2], M.F. Müller[2], M. Mengdehl[1], and L.A. Garbe[1,2], [1]Technical University of Berlin, Germany, [2]Neubrandenburg University of Applied Sciences, Germany.

Due to major crop loss in agriculture and an increasing health hazard from organic food, research institutions worldwide now focus on the discovery of naturally derived and produced biocides. Oxylipins such as trihydroxy fatty acids are assumed to occupy an important role in natural plant defense, possessing certain bioactive properties, including antifungal, bacteriocidal and insecticidal activity. Our research aims towards application of oxylipins as biological fungicides and preservatives in industry to improve health protection and food safety. According to Hamberg (1991a), there are 16 stereoisomers of THOE (trihydroxyoctadecadienoic acid), all of them most likely having different bioactive properties. Results on occurrence of trihydroxy fatty acid isomers in barley, beer and tomatoes are given, accompanied by explanation of methods for metabolomic screening through GC-MS, in order to achieve elucidation of formation pathways. In addition, novel ways for chemo-enzymatic synthesis of THOE are presented, including a method for low-cost, rapid and easy production at "every farmer`s stable". Finally, for evaluation of antifungal activity, methods and first results of microbiological inhibition tests with regards to selected, industrially relevant, plant pathogens and application on real plant species that are artificially infected are presented.

Phospholipids in Drug Delivery.
M.U. Ahmad ***(Alton E. Bailey Award Winner)***, Jina Pharmaceuticals Inc., USA.

Abstract not available at time of posting.

PHO-P: Phospholipid Poster Session

Chair: B. Sebree, Archer Daniels Midland Co., USA

1. **Inverse Gas Chromatography Determination of the Solution Thermodynamic Parameters Between Lecithin and Organic Solutes.** R. Araya[1], F. Temelli[1], and J.W. King[2], [1]University of Alberta, Canada, [2]CFS, University of Arkansas, USA.

Solute-solvent interactions between a lecithin-organic solutes are relatively limited in the literature and critical to understanding the miscibility and solubility of lecithin in various solvents. To better understand lecithin's solubility characteristics in various solvents, an inverse gas chromatographic (IGC) study was conducted, utilizing a commercial lecithin (68% phospholipids) as a column substrate and 25 solute probes that vary with respect to their volatility or polarity over the temperature range from 55-100^{o}C. Precise determination of the solute retention volume data on the lecithin columns yielded activity coefficients, Henry's Law constants, and chi interaction parameters for the various solute probe – lecithin pairs, and solubility parameters for lecithin as a function of temperature. The log of the specific retention volume vs. reciprocal of temperature plots were linear and varied less than 5% between multiple lecithin columns. Most solute probes at conditions approaching infinite dilution have X parameters less than their corresponding X_c values, indicating miscibility and solubility in lecithin. Lecithin's solubility parameter was found to vary from 20.0 to 18.3MPa$^{1/2}$ from 55 to 100^{o}C, respectively, in reasonable agreement with those calculated from group contribution method based on the molecular composition of the studied lecithin.