2011 Annual Meeting Abstracts

Edible Applications Technology

MONDAY

MORNING

EAT 1: Lipid Structures - Fundamentals

Chair(s): S. Narine, Trent University, Canada; and N. Garti, Hebrew University of Jerusalem, Israel

Phospholipids-Embedded Fully Dilutable Liquid Nanostructures ? Structure Reactivity Relationship. N. Garti, Casali Institute for Applied Chemistry, Hebrew University, Jerusalem, Israel

Complex pseudo-ternary phase diagrams based on sucrose monolaurate (SE), propylene glycol (PG) and various phospholipids (PL) as the ?surfactant phase?; triacetin (TA) and decaglycerol ester (10G1CC) as the ?oil phase? and water as the aqueous phase were constructed into which we solubilized water insoluble bioactives. In this study we examined the relationship between the chemical characteristics of the drugs and the type of the PL using DLS, viscosity, electrical conductivity, SAXS, SD-NMR and cryo-TEM measurements. It was found that: 1) the system remains micellar after aqueous dilution but with higher polydispersity and shapes. We concluded that the structures in the absence of water (but in the presence of PG) were of direct spherical micelles (~4 nm) mixed with elongated cylindrical micelles (12?120 nm); 2) the aqueous dilution causes fragmentation of the cylinders into smaller spherical micelles; 3) solubilization of Na-DFC behaving like kosmotropic agent or ?structure-maker? yields more ordered systems than in its absence and of mostly spherical swollen micelles; 4) Na-DFC is solubilized at the interface of the micelles without swelling the droplets.

TAG Isomers of Stearic and Oleic Acid: Symmetry-Induced Differences in Crystallization Behaviour. Suresh Narine[1], Laziz Bouzidi[1], Nissim Garti[2], [1]Trent Biomaterials Research Program, Trent University, Peterborough, ON, Canada, [2]Hebrew University of Jerusalem, Jerusalem, Israel

TAGs composed of Stearic and Oleic Acids occur in significant amounts in industrially relevant lipids such as cocoa butter, shortenings and margarines. The crystallization behavior therefore of isomers of these fatty acids are of importance as it contributes to the overall crystsallization behavior and ultimately, physical properties, of the lipids systems within which they are contained. As is widely known, for a given TAG, crystallization behavior can be altered to a certain extent by manipulating either thermodynamic or kinetic controls. The extent to which these controls are effective can however be drastically altered by the symmetry of the molecule and its impact on molecular diffusion and walll effects or reactivity of the particular isomer. This study demonstrates how one can change the kinetics as well as the polymorphic transformations of the crystallization by changing the internal molecular composition of the TAGs as well as the

rates at which the systems are cooled. The study focusses on symmetric and assymetric isomers of mono-unsaturated (SOS, SSO) and di-unsaturated (OSO, OOS) TAGs, of stearic and oleic acids.

The Propensity of Individual TAG Species to Bind Oil: Influence of Symmetry and Chain Length Mismatch. Suresh Narine[1], Laziz Bouzidi[1], Nissim Garti[2], [1]Trent Biomatrials Research Program, Trent University, Peterborough, Ontario, Canada, [2]Hebrew University of Jerusalem, Jerusalem, Israel

The ability of TAG species to bind oil in a network is of signifcant importance, particularly in lipid network systems with zero trans fat and significantly reduced saturated fat. In this study, pure saturated triacylglycerols (TAGs) were used as model systems to gain insight into the mechanisms of oil structuring. Different symmetrical and asymmetrical TAGs mixed with canola oil (CO), were crystallized from the melt down to room temperature and tested for the capacity of the fat network to bind oil. Two important parameters measuring the relative propensity of a solid network to lose oil were defined: (1) a quantified representation of the kinetics of oil loss, i.e. the Rate of Oil Loss, K, and (2) the initial amount of oil susceptible to be lost, a thermodynamic parameter, representing the Propensity for Oil Loss (POL). The "kinetic and thermodynamic doublet" (K and POL) provide an effective and predictive measure of the Oil Binding Capacity (OBC) of a given structurant. The effects of symmetry, molecular weight and chain length mismatch on the ability of a fat network to bind oil will be discussed.

Self-Assembly of Lyotropic Liquid Crystals: from Fundamentals to Applications. R. Mezzenga, ETH Zurich, Food & Soft Materials Science, Institute of Food Nutrition & Health, Zurich, Switzerland

In this talk I will review the recent progresses made on the understanding of self-assembly principles in lipidic lyotropic liquid crystals. I will discuss the thermodynamic driving force leading to self-assembly and will screen the advances made from the concept of the critical packing parameter up to date. Different thermodynamic models will be discussed with special emphasis on the implications these might have on bound and free water within the hydrophilic domains of the inverted lyotropic liquid crystalline mesophases. Finally, I will discuss how these concepts can be useful in designing and optimizing lyotropic liquid crystals for targeted delivery of active ingredients.

Physical Properties of the Binary Mixture of POP and PPO in *n*-dodecane Solution. S. Ueno[1], E. Ikeda[1], K. Sato[1], H. Mizobe[2], T. Nagai[2], K. Ichioka[2], K. Kojima[2], K. Tsurumi[2], [1]Hiroshima University, Higashi-Hiroshima, Hiroshima, Japan, [2]Tsukishima Foods Industry Co., Ltd., Edogawa-Ku, Tokyo, Japan

Studies of the binary mixture systems of POP and OPO, PPO, POO, PPP etc. are quite significant for the fractionation and confectionary fats design. The physical properties of these binary mixtures have already been studied, and the molecular compound (MC) formation has been found for POP/OPO and POP/PPO systems. The real system of crystallization in such as the fractionation of palm oil, however, has occurred in solution. A few studies has only been reported the binary mixtures of triacylglycerols in solution. In the present study, we tried to

elucidate the physical properties of the binary mixtures of POP and rac-PPO in n-dodecane solutions using DSC and synchrotron radiation X-ray diffraction simultaneous measurements (DSC/SR-XRD). The ratios of total solute of POP/PPO:n-dodecane were 50:50 (50 % solution) and 20:80 (20 % solution). The following results were obtained;(1) The phase behavior of the POP/PPO binary mixtures of 50 % and 20 % solutions basically show the combination of the two monotectic natures described as follows: (i) MC formations observed at POP:PPO = 50:50, and (ii) POP/MC and MC/PPO show the monotectic nature. (2) Even if POP/PPO:n-dodecane were 2:98 (2 % solution), MC formed in the solution.These results indicated that the molecular interaction between POP and PPO was quite strong.

Effects of Stereoscopic Isomerism and Racemization of Asymmetric Oleic-palmitic Mixed-acid Triacylglycerols (PPO and OPP). K. Sato[1], T. Tanaka[1], K. Sunakawa[1], S. Ueno[1], H. Mizobe[2], T. Nagai[2], N. Hatakeyama[2], K. Kojima[2], K. Ichioka[2], K. Tsurumi[2], [1]Hiroshima University, Higashi-Hiroshima, Hiroshima, Japan, [2]Tsukishima Foods Industry Co., Ltd, Edogawa-Ku, Tokyo, Japan

A plenty of asymmetric unsaturated-saturated mixed acid triacylglycerols (TAGs) are present in natural fats. Polymorphic and crystallization behavior of these asymmetric TAGs are influenced by mixing behavior of stereospecific isomers, however, few studies have been done to separately examine the effects of the mixing behavior of the isomers. This is mainly because of difficulty in obtaining pure stereoscopic isomers in individual manners. This paper presents a systematic work on the mixing behavior of R-PPO (*sn*-1,2-dipalmitoy-3-oleoyl-gycerol) and S-OPP(*sn*-1, oleoyl-2,3-dipalmitoy-gycerol), using >99% pure every isomer samples. Polymorphic behavior of pure isomers and mixing properties were examined with synchrotron radiation X-ray diffraction and DSC methods, and the following results were obtained.(1) R-PPO and S-OPP showed totally identical polymorphic behavior.(2) Eutectic mixing behavior was formed in the binary mixture of R-PPO and S-OPP. (3) The occurrence behavior of alpha form of every stereospecific isomer and racemic mixture was quite different. The present work indicated significant contribution of glycerol groups combined with oleic and palmitic acid moieties to the polymorphic properties of the aymmentric TAGs.

Mechanical Properties of Ethylcellulose Organogels as Affected by Oil Composition, Surfactant Type and Concentration, and Polymer Molecular Weight. A. Zetzl, A.G. Marangoni, S. Barbut, University of Guelph, Guelph, Ontario, Canada

Ethylcellulose has been recently shown by our laboratory to be an excellent organogellator for vegetable oils. The resulting gels maintain the fatty acid profile of the vegetable oil used, but posses a solid-like structure that can be useful for the replacement of saturated fats in food products. Three different molecular weights of ethylcellulose at a concentration of 10% were used to gel canola oil and soybean oil. Oil migration, texture profile analysis, and back extrusion were carried out in an attempt to quantify the various textural properties of the gels with the different ingredient combinations. The quaternary state diagram (polymer MW-surfactant-oil-mechanical response) will greatly aid in the manufacture of ethylcellulose organogels with specific textural properties to replace saturated fat in a variety of food products.

Scanning Microbeam Small-angle X-ray Diffraction Study of Gelator Crystals in Rice Bran

Wax-vegetable Oil Organogels. L. Dassanayake[1], D. Kodali[2,3], S. Ueno[1], K. Sato[1], [1]Hiroshima University, Higashi-Hiroshima, Hiroshima, Japan, [2]Global Agritech, Inc., Minneapolis, MN, USA, [3]University of Minnesota, Minneapolis, MN, USA

We performed scanning microbeam small-angle X-ray diffraction (μ-SAXD) experiments, differential scanning calorimetry (DSC) analysis, and optical microscopic observation of RBX crystals in 1% (w/w) RBX-salad oil (soybean oil: canola oil = 50:50) organogels. The scanning μ-SAXD experiment was performed by irradiating a synchrotron radiation X-ray microbeam having an area of 2 Ã? 2 μ^2 onto different positions on a RBX crystal at 20 Â°C. The crystallization of RBX in salad oil mixtures were carried out by cooling the mixtures from 80 Â°C to 20 Â°C at rate of 0.5, 1.0, 2.0 and 5.0 Â°C/min. ã??DSC study revealed that the RBX crystallization temperature in RBX-salad oil organogel is independent from the rate of cooling. The μ-SAXD experiment studies revealed that the lamella planes of RBX crystals were parallel to the long-axis of the crystal. The degree of orientation of the lamellar planes of RBX crystals was remarkably higher independent from the cooling rate. Polarized optical microscopic observations and the μ-SAXD experiment studies showed that the size of the RBX crystals was strongly related to the rate of cooling. These results demonstrate the unique and extreme crystal growth anisotropy of RBX crystals that lead to needle shape morphology.

Influence of Stereochemistry on the Crystallization and Polymorphism of Acylglycerols. R.J. Craven, R.W. Lencki, Department of Food Science, University of Guelph, Guelph, Ontario, Canada

To date, the role of stereochemistry in acylglycerol crystallization and polymorphism has not been fully appreciated. Stereochemical orientation is critical for defining the unit cell – yet this information remains elusive in even the most advanced single-crystal x-ray studies. Fortunately, this essential information is expressed through a racemate's tendency to form either: racemic compounds – where the unit cell contains both enantiomers; conglomerates – which are mechanical mixtures of enantiopure crystals; or pseudoracemates – which are solid solutions with no regular pattern. A characteristic phase diagram (constructed using binary mixtures of enantiomers) is associated with each of the aforementioned crystalline forms. Thus, phase diagrams for binary mixtures of enantiomers inform us of a racemate's crystalline tendency and, in turn, this provides information on stereochemistry within the unit cell. To this end, model enantiopure and racemic diacylglycerol and triacylglycerol molecules were prepared and their binary mixtures were used to prepare phase diagrams. In addition, the melting (DSC) and spectroscopic (IR and x-ray) properties for the enantiopure and racemic compounds were measured and compared providing surprising insight into one of the underlying causes of polymorphism in acylglycerols.

AFTERNOON

EAT 2: Lipid Structures - Applications

Chair(s): D. Nakhasi, Bunge Oils Inc., USA; and F. Orthoefer, FTO Food Research, USA

Evaluation of Low Saturate High Oleic Soybean Oil in Snack and Cracker Applications. R. Wilkes, L. Jurado, Monsanto Company, St. Louis, MO USA

The 2010 Dietary Guidelines for Americans has recommended a further reduction of saturated fat in the diet from 10% energy to 7% while continuing to eliminate industrial trans fats. Although many foods were reformulated prior to or following mandatory trans fat labeling in 2006, food companies continue to evaluate second generation oils that provide reduced saturated fat, improved stability, and improved cost and availability. A low saturate high oleic soybean has been developed through the combination of biotechnology and conventional breeding that has been shown to offer improved stability and the ability to reduce saturated fat in food. Recent studies have been conducted that demonstrate the use of this oil in snack applications including tortilla chips. Results that will be presented demonstrate improved fry performance over alternative oils including corn oil. The resulting tortilla chips have acceptable flavor performance initially and throughout the shelf life study and reduced saturated fat content. This oil can also be used as spray oil for crackers, also resulting in acceptable flavor performance.

Phytosterol Ester Enriched Shortening (PhytoBake) - Beyond Saturate Sparing. D. Nakhasi, R. Daniels, Bunge North America, Inc., Bradley, IL, USA

Phytosterols and phytosterol esters have been well documented to provide cardio benefits. However, phytosterols are commonly provided in either a powdered form (free sterol) or a viscous liquid form (sterol ester). The aim of this study was to confer the nutritional benefits of phytosterols and to create a crystal seeding structure. This was achieved by utilizing saturated fatty acids as structuring components for ester linkage in phytosterols. These phytosterol esters are solid at ambient temperature, which allows us to form a nutraceutical shortening without hydrogenation. The study also confirmed that this nutraceutical shortening when compared with low trans shortenings provides comparable SFC and MDPT, and is virtually trans free with reduced saturated + trans. The added benefit of this product has an ability to provide cholesterol lowering properties due to presence of phytosterol in the structure. Phytobake can be used in many applications. It can be utilized in place of other all purposes shortenings, to confer the nutritional benefits of phytosterols without affecting the taste or mouth feel of the finished product.

Formulation of Zero *trans*, Low Saturated and Nutritious Balance of Omega 9, 6, 3 Semi-solid Fat for Production of Digestive Cookies. F. Madadnoee[1,2], M.R. Modalal[1,2], F. Karami[1,2], H.R. Ghadri[3], H. Ebrahimi[3], [1]Agri-Industry & Veg. Oil of Mahidasht, (A.I V. O. M. Co.), Kermanshah, Iran, [2]Kesht Va Sanat Shomal(KVSS), Mazandaran,Iran, [3]Minoo Cookies and confectionary Company, Khorramdare, Iran

In the first part of a 3-phase applied research we successfully eliminated trans fatty acids from all of our products. One of the challenges in keeping the applicability of the products in almost all trans free shortenings was the need to increase the saturated fatty acids. In the second phase of the study by collaborating with a consumer company, we formulated a new low saturated semi-solid fat with more or less the same melting point of high saturated shortenings. This new product is already replaced the high saturated shortening by consumer companies. The color, texture and taste of cookies were evaluated by sensory panel. The results of sensory evaluation

revealed superiority of the new product in all tested attributes compared to conventional products. In the third phase to keep the balance of three unsaturated fatty acid, omega 9, 6 and 3, we raised the ratio of omega 9 and 3 and lowered the ratio of omega 6, by changing the type of blended liquid oils. Formulated fat were used in production of digestive cookies in industrial scale. Results of the sensory analysis showed preference towards the new formulation. The fatty acid composition of the formulated semi-solid fat is; Total saturated fatty acids 15%, omega 9, 58%, omega 6, 21% omega3, 6% and omega6 to omega3 ratio 3.5.

Enzymatic Interesterification for Functional Bakery Shortenings. B. Johnson, A. Bedford, K. Hays, Bunge North America Inc., Bradley, IL, USA

Enzymatic interesterification has been shown to be a viable tool for the production of trans free baking. Additional development efforts have led to functional enhancements allowing for production of bakery shortenings meeting higher performance requirements including frying, lamination and icings. These new developmental shortenings have been evaluated versus other products commonly used.

Practical Applications of Soymega™ (SDA Soybean Oil) into Food Products. Jane Whittinghill, Jennifer White, Beata Lambach, David Welsby, Seok Lee, Candice Lucak, Xianqping Pan, Solae, LLC, St. Louis, MO, USA

The consumer market for omega-3 continues to expand as increasing evidence points towards the health benefits of consuming dietary omega-3 fatty acids. Soymega™, SDA soybean oil, intended for use as a food ingredient, offers a plant-based sustainable source of omega-3 fatty acid that can be efficiently converted to eicosapentaenoic (EPA) acid in the human body. Soymega™ has already been used successfully in a number of food applications. This presentation investigates the use of Soymega™ in the formulation of fat powders, margarines, soups and sauces.Fat powder and margarine were manufactured using palm based oil and Soymega™ according to standard industrial procedures. The fat powders were used for the manufacture of a dry blended soup while the margarine was used in a cookie formulation to deliver an amount of SDA per serving. Soymega™ has been successfully incorporated into formulations of cream and tomato sauces. All sensory evaluations were conducted using the 9-point hedonic consumer acceptance scale and descriptive sensory profiling scale. Sensory data shows that Soymega™ can be directly or indirectly used to deliver acceptable flavor, texture and mouth-feel in food products.

Practical Texture Measurement for the Food Industry. J.D. Guy, H. Shuman, Bunge North America, St. Louis, MO, USA

Texture or firmness is important to the food ingredient and food processing industries due to its effect not only on palatability of finished products, but also on the processes used to produce various products. Many methods have been employed to measure texture of food and food ingredients with varying levels of complexity and of success. Most methods are not suitable for shop-floor measurement. This presentation describes an instrument and method developed for measuring texture. The method can be used in the ingredient warehouse or on the production shop floor, under the conditions of use and on the actual ingredients being used. The principles

of operation and testing procedures are described. Configuration and operation of the instrument are shown. Case studies are presented which illustrate the method and interpretation of data gathered with the instrument. Case studies include various shortening applications, icings and doughs.

TUESDAY

AFTERNOON

EAT 3 / S&D 3: Film, Emulsions, and Foams

Chair(s): A. Wright, University of Guelph, Canada; D. Kim, Kraft Foods Inc., USA; and C. Rojas, AMCOL, USA

The PIT Emulsification Process: Reality Versus Intuition. S.E. Friberg, Clarkson University, Potsdam, NY, USA

The PIT (Phase Inversion Temperature) emulsification produce emulsions with a large fraction of oil drops that are significantly smaller than those obtained from traditional mixing process. The process is widely used, but its fundamentals have not been clarified.The emulsification is carried out in two stages: 1. A primary mechanical dispersion at the PIT, with three phases (water, an inverse micellar solution, and a bicontinuous microemulsion) in the emulsion. 2. Immediate cooling to application temperatures, reducing the number of phases to two; an O/W microemulsion and an inverse micellar hydrocarbon solution. A rational explanation for the smallness of the drops has assumed them to emanate from the colloidally dispersed hydrocarbon in the original bicontinuous microemulsion. However, a quantitative analysis of the phase fractions in an emulsion of water, hexadecane and tetraoxyethylene dodecyl ether versus temperature revealed that the original water phase is not retained as the final aqueous phase. The final aqueous phase is instead formed by the microemulsion absorbing water during the cooling stage, gradually modifying the bicontinuous microemulsion structure to become water continuous. In the process a minor part of the original microemulsion is separated, forming the small oil drops.

Design and Application of Functional Food-Grade Nanoemulsions. D.J. McClements, Department of Food Science, University of Massachusetts, Amherst, MA 01003, USA

Nanoemulsions fabricated from food-grade ingredients are being increasingly utilized in the food industry to encapsulate, protect, and deliver lipophilic functional components, such as biologically active lipids (e.g., ω-3 fatty acids, conjugated linoleic acid) and oil-soluble flavors, vitamins, preservatives, and nutraceuticals. The small size of the particles in nanoemulsions ($r < 100$ nm) means that they have a number of potential advantages over conventional emulsions: higher stability to droplet aggregation and gravitational separation; high optical clarity; ability to modulate product texture; and, increased bioavailability of lipophilic components. On the other hand, there may also be some risks associated with the oral ingestion of nanoemulsions, such as their ability to change the biological fate of bioactive components within the gastrointestinal tract and the potential toxicity of some of the components used in their fabrication. This presentation

provides an overview of nanoemulsion formulation, fabrication, properties, applications, and biological fate with emphasis on systems suitable for utilization within the food and beverage industry.

Fate of Oil-in-Water Emulsions Under Gastrointestinal Simulated Conditions: Evolution of Molecular and Supramolecular Lipid Structures. H.B. Kenmogne Domguia, A. Meynier, C. Genot, INRA, UR1268 Biopolymères Interactions Assemblages, Nantes, France

The understanding of the fate of emulsified lipids within the gastrointestinal tract may assume particular interests for the design of functional foods. The purpose of this study is to set up the experimental conditions allowing assessment of the molecular and supramolecular fate of oil-in-water emulsions during *in vitro* digestion.Emulsions, with well-characterized droplet size distributions and stabilized by different emulsifiers were submitted to *in vitro* digestion conditions that simulate mouth, stomach and then upper small intestine environments. Supramolecular changes of emulsified lipids were monitored by microscopies and light scattering techniques, whereas, formation of lipids digestion products were assessed by liquid chromatography. Other measures concern lipid oxidation.In stomach conditions, gastric juice composition and/or gastric pH led to profound modifications of lipid organization, characterized by different extend of flocculation and/or coalescence. In small intestine, structures smaller than µm containing lipids digestion products and biliary salts are evidenced. The results show the key impact of the digestion conditions on the fate of lipids and the interest to validate data obtained *in vitro* by *in vivo* studies

Development of Thermodynamic Correlations to Predict the Stability of Emulsified Formulations. S.K. Kiran, E.J. Acosta, University of Toronto, Toronto, ON, Canada

Emulsions are classified as micrometer-sized droplets of one medium dispersed throughout another with which it is naturally immiscible (i.e. oil and water). Being a thermodynamically unfavourable process, emulsification is facilitated by the presence of surfactants that act to reduce the interfacial tension and promote droplet formation and break-up during mixing. A critical design parameter in the formulation of emulsified systems is their stability. It has been reported that this property is strongly linked to the phase behaviour of its corresponding microemulsion formulations. Developing an understanding of the fundamentals governing this relationship is of great interest as it may potentially allow for the prediction of dynamic properties from equilibrium-based correlations. As an initial modelling attempt, the stability of well defined surfactant (sodium dihexylsulfosuccinate)-oil (toluene)-water systems will be predicted. Having done so, various industrially related processes will be characterized such as crude oil recovery from rag layers and vegetable oil extraction from oil seeds. All modelling results will be validated experimentally using an in-house designed multipoint turbidity meter.

Physicochemical Properties of Lactoferrin-stabilized Oil/Water Emulsions: Effects of pH, Salt, and Heating. T. Tokle, D.J. McClements, University of Massachusetts Amherst, Amherst, MA, USA

Lactoferrin (LF), a cationic bovine globular protein with a high isoelectric point (pI~8), may lead to novel functional properties in foods and other products. We investigated the influence of pH

(2-9), NaCl/CaCl2 addition (0-200mM), and thermal processing (30-90ºC, 20min) on the stability of LF-stabilized o/w emulsions. At ambient temperature, emulsions were stable at pH≤6 but exhibited some droplet aggregation from pH 7-9. The thermal stability of the emulsions depended on pH, holding temperature and thermal history. When LF-coated droplets were heated in distilled water and then their pH was adjusted from 2-9, they were highly unstable to aggregation at pH 7 and 8. On the other hand, when the pH was altered first and then heated, the droplets were highly unstable to aggregation at pH≥5 when heated above 50ºC. The stability of emulsions to salt addition depended on pH and salt type, which was attributed to counter-ion binding and electrostatic screening effects. For NaCl, emulsions were stable from 0-200mM at pH 3 and 9, but aggregated at ≥100mM at pH 6. For CaCl2, emulsions were stable from 0-200mM at pH 3, but aggregated with ≥150mM CaCl2 at pH 6 and 9. These results have important implications in LF-stabilized emulsion-based products.

A Study of Polyaphron (Biliquid Foam) Systems. S.T. Adamy, Church & Dwight Co., Inc., Princeton, NJ, USA

Polyaphrons, or biliquid foams, are systems composed of relatively high volume fractions of oil dispersed in aqueous media. The volume fraction of oil in these systems is higher than that for systems of closely packed monodisperse spheres ($\varphi = 0.74$). Droplets are concentrated enough that they deform into polyhedral shapes. The droplets are separated and stabilized by thin films of the aqueous phase. In this way, these systems resemble gas-liquid foam systems, with the gas phase replaced by the oily phase. This paper will present findings on the preparation and characterization of polyaphron systems incorporating various alkanes and surfactants. Results of rheological measurements, optical microscopy, and Karl-Fischer titrations (for water) will be presented and used to discuss trends with changing composition.

****Cancelled** Partial Coalescence Revisited.** Roja Ergun, University of Wisconsin-Madison, USA

WEDNESDAY

MORNING

EAT 4 / FS&FF 4: Cocoa Butter and Chocolate Structuring

Chair(s): N. Widlak, ADM Cocoa, USA; and K. Dewettinck, Ghent University, Belgium

Ultrasonic Characterization of Dispersions of Sugar in Vegetable Oil. U. Yucel, J.N. Coupland, The Pennsylvania State University, Umiversity Park, PA, USA

Solid-in-oil dispersions are common in foods (e.g., liquid chocolate, flavor slurry suspensions) yet their properties are difficult to monitor, particularly online. In the present work we consider the use of ultrasonic sensors to characterize the properties of oil-continuous dispersions of sucrose. Through-transmission ultrasonic attenuation measurements (2.25 MHz) were used to

monitor changes during dispersing, agglomeration, and sedimentation of sucrose crystals (8-16 wt%, d ≈ 29.8 μm) suspended in vegetable oil. Following the addition of sugar into the stirred oil, ultrasonic attenuation increased instantaneously due to the presence of air pockets in and around the clusters of sucrose crystals, and then decreased back to a steady-state value proportional to sugar concentration. Next, the dispersed crystals were agglomerated by the addition of small volumes of water (0-1%). Ultrasonic attenuation increased over several minutes following the addition of water. Finally, the agglomerated crystals were allowed to sediment quiescently. Agglomeration decreased the time taken for the sucrose to sediment, but was not uniform suggesting the formation of different sized-populations of crystals. The presence of a few, very large particles was confirmed by micrometer measurements.

A Novel Approach to Measure Yield Stress in Chocolate. V. De Graef[1], F. Depypere[1], M. Minnaert[2], K. Dewettinck[1], [1]Ghent University, Ghent, Belgium, [2]Barry Callebaut, Aalst, Belgium

In terms of rheology, liquid chocolate shows a non-Newtonian behavior that can be characterized by a yield stress and plastic viscosity. The flow behavior is influenced by processing parameters such as conching, the fat content, the amount and type of emulsifiers, the particle size distribution and tempering. In general, yield stress is determined by shear rheology experiments and the data are plotted as viscosity as a function of shear stress or shear stress as a function of shear rate. For the shear stress-shear rate plot, a frequently used approach to estimate the yield stress is to fit the data to one of several models. Even though IOCCC recommendation is not to use the Casson model, it is still frequently applied as it provides a good fit to the experimental data for the shear rate ranging from 5s-1 to 60s-1. However, this model is unable to resolve real differences between chocolate samples that manifest outside this region. In this study, oscillatory rheology was. was applied and the stress at the end of the LVR is taken as an estimate for the yield stress. As such, the yield stress could be determined without the use of mathematical models or stress values at fixed shear rates.

Influence of Cocoa Butter Refining on the Quality of Milk Chocolate. N. De Clercq[1], K. Moens[1], F. Depypere[1], J. Vila Ayala[2], W. De Greyt[2], K. Dewettinck[1], [1]Ghent University, Ghent, Belgium, [2]Desmet Ballestra Group, Zaventem, Belgium

Cocoa butter was subjected to a refining process by applying a silica treatment and/or a packed column steam refining. The silica treatment of cocoa butter improves its quality by removing primary and secondary oxidation products. The steam refining primarily removes free fatty acids being the deterioration products of lypolysis. During the refining process the column temperature and the amount of silica was varied to obtain cocoa butters with a different refining quality. In the next step the cocoa butters were used in the production of a milk chocolate. DSC, rheology and texture analysis were used to investigate the effect of refining of cocoa butter on the final milk chocolate quality.

Chocolate Microstructure Influences Oil Migration Rates. D. Rousseau, M. Arduini, Ryerson University, Toronto, Ontario, Canada

The objectives of this study were to assess the effects of 3 moulding temperatures (5, 15 and 20

°C) on the microstructure, oil migration kinetics and volume of a model filled confection consisting of laboratory-tempered dark chocolate and a hazelnut oil/icing sugar filling. Significant changes in chocolate microstructure were observed based on the moulding temperature used, which also impacted oil migration kinetics. Using HPLC, triolein from hazelnut oil was used as the marker to monitor migration in relation to the 1,3-distearoyl-2-oleoylglycerol peak representing cocoa butter. Using a Fickian model, the mechanism for the migration of foreign triacylgycerols into chocolate was evaluated for 1 month. Deviations from Fickian diffusion were noted with increasing storage time, and resulted from the fat solubilization-induced breakdown of the chocolate matrix. The rate of migration and diffusion coefficient was significantly higher for the 15 °C moulded chocolate, resulting in a confectionery product with a severe loss in quality. The filled dark chocolates tempered at 20 °C showed the smallest increase in volume and most negligible deterioration over 4 weeks. Overall, the results from this study offered some insight into the optimization for the production and storage of filled chocolates.

Crystallization of Cocoa Butter. R. Campos[1], A.G. Marangoni[2], [1]Mars Chocolate North America, USA, [2]University of Guelph, Guelph, Ontario, Canada

This investigation into cocoa butter crystallization examines the effects of extrinsic (i.e., crystallization temperature and shear) and intrinsic (i.e., molecular make-up) conditions on the crystallization process and different structural levels. The degree of undercooling -affected by storage temperature- affects how different lipid species attach to growing nuclei. Lower storage temperatures result in rapid crystallizations, neglecting other process conditions. Higher storage temperatures allow for the effects of processing conditions to become evident. Shearing of the melt during cooling results in sporadic nucleation and increased crystallization kinetics, microstructures formed by numerous small particles with higher mechanical strength and melting point. Without shear, crystallization becomes disordered: lipid species progressively attach onto growing crystals according to melting point, leading to fractional crystallization events evidenced by compositional and thermal behavior differences at various crystallization times compared to natural cocoa butter. Specific temperature and mixing profiles steer fat crystallization in industrial applications targeting macroscopic properties. In this work we also examined the effect of small compositional changes on structural levels and functionality by adding highly saturated tristearin and highly unsaturated trilinolein. Increased concentration of saturated molecules accelerates crystallization kinetics while delaying polymorphic transformations. Conversely, highly unsaturated molecules remain liquid in the crystal network?s liquid fraction, enhancing molecular mobility and accelerating polymorphic transformations.

Rheo-NMR and Synchrotron X-ray Diffraction Characterization of a Crystallizing Triglyceride Mixture. M. Li, G. Mazzanti, Dalhousie University, Halifax, NS, Canada

Shear flow affects the solid content (SC), polymorphism, and phase distribution of fats. Binary mixtures of pure Trialurin and Trimyristin in a ratio of 7:3 were diluted to 60% or 40% in non-crystallizing Triolein. 40%7L3M was cooled at 10˚C/min from the melt at 60˚C down to 14˚C, 16˚C and 18˚C; 60%7L3M was cooled to 17˚C, 20˚C and 23˚C. The samples were crystallized at each temperature either statically or under shear rates of 800, 80, and 8 s^{-1}. The sample cell combined a rheometer with a nuclear magnetic resonance (NMR) spectrometer to measure SC

values. Viscosity and total mechanical energy delivered were precisely measured by the rheometer. The measurements were compared to common equations that describe the dependency of viscosity on solid volume fraction, to understand the effect of orientation of the crystallites at higher shear rates. To complement the study, phase transitions during crystallization were observed by time-resolved synchrotron x-ray diffraction with the same samples under the similar conditions. The cell used had the same rheometer, temperature control and geometrical characteristics as the cell in the NMR. Shear induced a strong reduction in phase transition time and variations in phase distributions, observed in both small and wide angle X-ray diffraction.

Determination by Synchrotron X-ray Microbeam of Local Compositions in a Spherulite Made by Two Triglycerides. G. Mazzanti[1], E. Ikeda[2], S. Ueno[2], K. Sato[2], [1]Dalhousie University, Halifax, NS, Canada, [2]Hiroshima University, Hiroshima, Japan

Predicting the crystallization path of multicomponent triglycerides is difficult due to their ability to form polymorphs and solid solutions, as well as to their usual inability to form large crystals. When a binary mixture of triglycerides crystallizes, it undergoes simultaneously a fractionation process. This makes it very difficult to relate bulk averaged measurements to crystallization phenomena at the crystallizing interface. Though we have advanced in the understanding of these processes, we still do not have proven phase diagrams and kinetic models to describe them. This becomes even more difficult for multicomponent systems. In this talk we present results of using synchrotron microbeam x-ray diffraction (Photon Factory, Tsukuba, Japan) to explore spherulites crystallised from a melt of trilaurin and trimyristin. We retrace the steps of the crystallization process as its story developed, by obtaining local diffraction patterns inside the spherulite. From them we extract local compositional information as a function of position. The history of crystallization is then compared to a model for phase diagrams of binary triglyceride mixtures proposed in the literature. It becomes apparent that the model cannot properly predict the crystallization path followed by the mixture.

Ethylcellulose Solvent Substitution Method of Preparing Heat Resistant Chocolate. T. Stortz, A.G. Marangoni, University of Guelph, Guelph, ON, Canada

The development of a heat resistant chocolate (HRC) has been a formidable task challenging researchers since the 1940?s. Today we have focussed on utilizing novel structuring techniques to produce chocolate which resists deformation at temperatures above 40°C. It was hypothesized that by adding ethylcellulose solubilised in ethanol to chocolate and evaporating off the EtOH an organogel could be formed in situ with the fat phase of the chocolate. HRC was produced by mixing a 20% EC in EtOH solution with molten chocolate. The EtOH was evapourated off and the resulting chocolate was inclubated at 40°C for 2hr and tested for hardness. It was found that milk chocolate with 1.9% EC had a hardness of 2646gf whereas the control chocolate was too soft to be tested. Further experiments revealed that white and dark chocolates had hardness of 3007 and 1074gf respectively. The hardness of the chocolate was dependent on chocolate type, amount of EC, and molecular weight of the EC. Addition of EC to chocolate represents a new strategy for manufacture of HRC. Future work should focus on determining the mechanism by which heat resistance is achieved in these chocolates.

Novel Utilization of Mahua (*madhuca longifolia*) Seed Fat as Cocoa Butter Replacer from the Central India Region. Bhalchandra P. Vibhute, Anand S. Kulkarni, Laxminarayan Institute of Technology, Rashtra sant Tukdoji Maharaj Nagpur University, Nagpur(M.S.),INDIA, Nagpur, Maharashtra, India

Mahua (Madhuca longifolia syn. Brassica longifolia) is the widely accepted as local name for the fat from both these species. The seed and oil potential of this tree in the country is 5.00 lakh and 1.8 lakh M. tonne. The Mahua seed found in the Central India Region contains 35% oil and 16% protein. Mahua seed belongs to the botanical families of Central India region were subjected to physico-chemical properties and lipid class determination to identify their uses for commercial exploitation such as utilization of it as a cocoa butter replacer. The physicochemical properties of fat extracted from Mahua Seed found in Central India were Color: Pale Yellow, Refractive index at 40° C:1.452 ,Specific gravity at 15°C:0.856,Iodine value :58.00,Saponification value:187 etc. It is found that the Mahua kernel fat having superior quality characteristics as compare to the Cocoa Butter. Also it is cost effective over cocoa butter. At present very little work has been carried out on commercial exploitation of these seed oils in India. The work will be a step towards it, thus generating additional revenue for the poor farmers of the Central India Region to improve their standard of living.

Impact of Deodorization on the Crystallization Properties and Solidification Behavior of Cocoa Butter. A. Lechter[1], N. Widlak[1], D. Sikorski[2], G. Karcher[2], [1]ADM Cocoa, Milwaukee, WI, USA, [2]ADM Research, Decatur, IL, USA

Deodorizing cocoa butter is a common industry practice to enhance the physical properties of cocoa butter by reducing free fatty acids, reducing color and reducing flavors. However, the crystallization properties of cocoa butter which are impacted by the minor constituents removed and/or altered during the deodorization process have a significant impact on solidification behavior and functional performance of chocolates manufactured with deodorized cocoa butters. This paper will review the changes in minor lipid components, crystalline properties and solidification behavior of cocoa butter deodorized under varying process conditions. Data on crystallization kinetics, crystallization and melting profiles, solidification rates and crystal structure will be presented in addition to standard commercial methods to measure cocoa butter quality.

AFTERNOON

EAT 5: General Edible Applications

Chair(s): B. Farhang, University of Guelph, Canada; and G. List, USDA consultant (Retired), USA

Physical and Chemical Properties and Oxidative Stability of Whey Protein Encapsulated Fish Oil as Affected by Encapsulation Method. N. Dunford, Oklahoma State University, Department of Biosystems and Agricultural Engineering and Robert M. Kerr Food and Agricultural Products Center, Stillwater, OK, USA

Microencapsulation improves oxidative stability and shelf-life of fish oil (FO). Spray and freeze drying are widely used to produce microcapsules. Newer spray-nozzles utilize multiple fluid channels allowing for mixing of wall and core materials at the point of atomization. Sonic energy has also been employed as a means of atomization. The objective of this study was to examine the effect of encapsulation techniques on physical and chemical properties and oxidative stability of whey protein encapsulated FO. Four methods, freeze drying, spray drying by 2- and 3-fluid pressure nozzles, and spray drying by a 2-channel ultrasonic nozzle, were examined. FO was the control. The storage tests were carried out at 5 and -18oC. Oxidative stability of the microcapsules was determined over a 15 week period in which HS-SPME was used to analyze volatile lipid oxidation products by GC-MS. The relative quantity of volatile oxidation products in microcapsules and fish oil were calculated by taking the ratio of the peak area of the compound of interest to the area of the internal standard (PAR).It was shown that microcapsules produced by multi-fluid nozzles generated lower amount propanal than that produced by fish oil and freeze dried samples throughout the course of a 15 week stability test. While the microcapsules produced by using a conventional 2-fluid pressure nozzle generated hexanal and 1-penten-3-ol, these compounds were not detected in the products from 3-fluid pressure and 2-fluid sonic nozzles.Physical and chemical properties of freeze dried microcapsules were compared to those of microcapsules produced by spray drying. The 2-fluid pressure and ultrasonic nozzles had the highest (91.6%) and the lowest microencapsulation efficiencies (76%), respectively. There was no significant difference in bulk density of microcapsules produced by ultrasonic and 3-fluid pressure nozzles. The ultrasonic nozzle showed a significantly narrower particle size distribution than the other nozzles. This study demonstrated that 3-fluid pressure and 2-fluid sonic nozzles produced microcapsules with similar or better oxidative stability than that of conventional 2-fluid pressure nozzle and eliminated the requirement for an oil/whey protein emulsion preparation prior to drying.

Study on Stability of Blends with High Percentage of Liquids Oils. Sivaruby Kanagaratnam[1,2], Miskandar Mat Sahri[1], Md Enamul Hoque[2], Andrew Spowage[2], [1]Malaysian Palm Oil Board, Selangor, Malaysia, [2]The University of Nottingham Malaysia Campus, Selangor, Malaysia

Fat blends with high percentage of liquid oil are usually unstable as oil tends to migrate out. This study was carried out to evaluate the ability of palm stearin IV 14 to improve the stability. Soybean oil was blended palm stearin IV14, with blending ratios of 97.5:2.5, 95.0:5.0, 92.5:7.5 and 90.0:10.0. These blends were heated to 70°C then stir cooled to 15°C and stored at 10°C. In this study, the stability of the blend was evaluated by testing the centrifugal separation of liquids.The blends were analyzed through variations in light transmission over time under the influence of centrifugal forces by advanced centrifugation stability analyzer, LUMiFuge®. Centrifugal force causes variation in the optical density as liquid migrate to the top and solids sediment at the bottom. The percentage of liquid migration in soybean: palm stearin blends of 97.5:2.5, 95.0: 5.0, 92.5:7.5 and 90:10 were 80%, 66%, 5% and 0%, respectively. It was observed that the migration of liquid oil reduced as the amount of palm stearin increased. The results show that the palm stearin IV 14 is able to form a homogenous solid with the soybean: palm stearin ratio of 90 : 10 at 15°C. Furthermore the solid fat content (SFC) of this blend at 5°C, 10°C, 15°C and 20°C were 12%, 11%, 9%, and 8%, respectively. In conclusion, the SFC is

promising as blend for refrigerated margarine.

Lipase-Catalyzed Interesterification of Beef Tallow with High Oleic Sunflower Oil and Rice Bran Oil. N. Segura, M.J. Pardo, I. Jachmanián, Laboratorio de Grasas y Aceites. Facultad de Química, Universidad de la República, Montevideo, Uruguay

Beef tallow (BT) is an important animal fat widely used in the food industry, however, it suffers from several drawbacks associated with it?s highly saturation degree (nutritional and thermal properties, crystallization behavior and crystal morphology, etc). In this study these characteristics were substantially improved destined BT to the enzymatic interesterification with two different vegetable oils: rice bran oil (RBO) and high oleic sunflower oil (HOSFO). Incubations were performed using blends of BT with different proportions of each oil, adding 10% wt of Lipozyme TL-IM, at 60ºC for different periods. Products were analyzed by GC and HPLC with ELSD detector, thermal properties and Solid Fat Contents (SFC) were determined by DSC and the crystallization behavior by Polarized Light Microscopy and XRD.Products from BT/HOSFO showed an increasing concentration of TAGs type SUU and a reduction in the concentration of SSS with respect to the starting blend, as the percentage of oil increased. While in the case of the blend BT/RBO TAGs type SSU were increased.Results show that selecting the oil and blend composition it is possible to conveniently design a product with improved physicochemical and nutritional properties than that corresponding to the original BT.

Developing Unique Fatty Acid Combinations through Traditional Sunflower Breeding Methods. B. Vick[1], L. Kleingartner[2], [1]USDA, ARS, Sunflower Research Unit, Fargo, ND, USA, [2]National Sunflower Association, Mandan, ND, USA

There have been a plethora of new fatty acid developments in a number of oilseeds that are either in research or have been introduced into the market place. There are many challenges in changing the fatty acid structure of an oilseed. Yield drag is one concern as is fatty acid consistency depending on geography, growing season weather and other variables. The U.S. sunflower industry has had good success in making new fatty acid adaptations. That may be due in part to the genetic adaptability of sunflower. There is also a significant USDA storehouse of seed types which includes wild species and domesticated sunflower. Researchers have screened this storehouse for unique fatty acid combinations which can be integrated into cultivated sunflower. Sunflower breeders developed both a high oleic and a mid-oleic sunflower which now dominate the North American market and to some extent the European market. This was market driven by demand for stable frying oils without need for hydrogenation. Additional opportunities exist to develop sunflower oils with unique fatty acid combinations. The success of new introductions is dependent on an identified market need and the ability of breeders to create the required fatty acid combination. This is done through traditional breeding methods.

The Role of Mixing Temperature on Microstructure and Rheological Properties of Butter Blends. P. Buldo, L. Wiking, Aarhus University, Tjele, Denmark

The present study demonstrated that rheological properties of butter blends can be modified by the applied mixing temperature. Blends were prepared by mixing 0, 10 or 25% of rapeseed oil (RO) with butter, at three different temperatures (13, 18 and 23°C). Afterwards the blends were

stored at 5°C until analysed. Microstructure, rheological properties and solid fat content of blends were examined.The viscoelastic properties of blends were measured by rheological oscillation analysis. Mixing at 23°C always resulted in the lowest $|G^*|$, hence less firm blend, independently of the content of rapeseed oil. No general effect was observed between mixing temperatures of 13 and 18°C on $|G^*|$, although $|G^*|$ of butter blends with 10% RO was lower for 13°C mixing than 18°C. The microstructure of the blends was analysed with confocal laser scanning microscopy, and this explain the effect on the rheological behaviour. The microstructure analysis showed that a high content of rapeseed oil and high process temperature produce a less dense crystal network and a change in protein/water distribution. In contrast, the level of solid fat content was not related straightforwardly to the viscoelastic properties of the blends.This study shows that high mixing temperature inhibit the availability to rebuild rigidity of crystal network in blends.

****Cancelled** Effect of Processing Conditions and Stabilizer Components on Physicochemical and Stability Properties of Astaxanthin Nanodispersions.** N. Anarjan Kouchehbagh, Universiti Putra Malaysia, Malaysia

Novel Formulation of Zero-*trans*, Low Saturate Iranian Vanaspati Using Palm Free Interesterified Oil Base Stocks and Blending Techniques. M. Jozi[1], M. Aghighi Ravan[1], P. Rashtchi[2], [1]R&D Department, Jahan Vegetable Oil Co, Zanjan, Zanjan, Iran, [2]Department of Food Science and agriculture, Tabriz university, Tabriz, Iran

Palm free interesterified oil base stock(IOBS) and blending techniques were used to produce zero-trans, low saturate Iranian vanaspati fat. Fully hydrogenated soybean oil(FHSO) or fully hydrogenated sunflower oil (FHSFO) mixed with a native vegetable oil like soybean oil (SBO) or sunflower oil (SFO) and the blends were subjected to chemical interesterification reaction on laboratory scale (using sodium methoxide as catalyst). The interesterified oil (IO) then mixed with rapeseed oil (RSO), SBO or SFO in order to obtain the Iranian vanaspati fat. The IO and final blends were investigated for slip melting point (SMP), Induction period(IP) of crystallization at 20 °C, Iodin value (IV), Oil Stability Index (OSI), trans fatty acid (TFA) and saturated fatty acid (SFA). The final blends also were investigated for oil separation after crystallization in room temperature. The blends of IO(prepared by FHSFO and SFO) and RSO had the lowest SFA and IP of crystallization. Zero trans, low saturate Iranian vanaspati fat could be prepared from blend with 50% IO(65% SFO and 35% FHSFO) and 50% RSO and no oil separation was seen after crystallization of fat blend.

Edible Applications Technology Posters

Chair(s): B. Kickle, ADM Food Oils Research, USA

Microviscosity of Fat Globules in O/W-emulsions Studied by EPR.
M.B. Munk[1,2], M.L. Andersen[2], [1]Palsgaard A/S, Juelsminde, Denmark, [2]University of Copenhagen, Department of Food Science, Frederiksberg C, Denmark

A method based on electron paramagnetic resonance (EPR) and the spin probe TEMPO (2,2,5,5-tetramethyl pyrrolidin-1-oxyl) has been developed in order to measure the separate microviscosities of lipid and water domains in emulsions. The method was used to study the effect of temperature on the microviscosity and thus the physical state of emulsified palm kernel oil in water in a temperature range from -15 °C to 30 °C. Information about molecular mobility in the lipid domain was correlated to viscosity by combining the results with the mobility and viscosity of low melting pure oils. The molecular mobility in fat globules increased with increasing temperature implying a decline in viscosity. A heating-cooling ramp hysteresis was observed in the temperature range of -5 °C to 20 °C due to crystallization delay in supercooled emulsified droplets. The viscosity of the continuous water phase was not affected by changes in temperature. The EPR method further gives information about the temperature dependence of partitioning of small solutes between the lipid and aqueous phases, proposing a technique to indicate the partition and performance of the emulsifiers in O/W-emulsion.

Composition and Thermal Behavior of Fatty Materials from Chocolate-covered Foods.
I. Vieitez, B. Irigaray, N. Urruzola, I. Jachmanián, M.A. Grompone, Laboratorio de Grasas y Aceites, Departamento de Ciencia y Tecnología de los Alimentos, Facultad de Química, Universidad de la República, Montevideo, Uruguay

The Pan American Health Organization made recommendations about reducing the level of trans fatty acids (TFA), originated in the hydrogenation of oils, because they adverse effects on human health. In Uruguay, and in general throughout Latin-American, there is not accurate information about the ranges of TFA included in the diet. Thus, it is essential to know the content of TFA in edible fats that usually contain them and to determine their thermal properties, in order to look for possible replacements.This work studied the fatty acid composition and thermal behavior of fatty materials extracted from foods with chocolate coatings commercialized in Uruguay.Results showed that when partially hydrogenated oils (non-lauric substitute of cocoa butter) were involved in chocolates formulations, it may contain high percentages (>40%) of TFA. Depending on the type of food concerned, will be the contribution of TFA coverage. Partial replacement of TFA with saturated fats is a solution for the physical behavior and improved from a nutritional standpoint. We also found that food fabricated with two "components", the composition of their fat and its thermal behavior are different, according to their application. The study of thermal behavior of fatty materials provides valuable information for choosing possible substitutes with low TFA.

A Thermal Approach to Estimate the Final Compositions of a Lipid Binary Mixture Crystallized Statically under Non-isothermal Conditions: Remarks on the Use of Heat-flux DSC in the Study of Lipids.
O. Al-Qatami, G. Mazzanti, Dalhousie University, Halifax, Canada

The effect of using different cooling rates (20, 15, 10, 7.5, 5, 2.5 and 1 °C/min) on the final compositions of pure triglycerides (Trilaurin and Trimyristin) and their binary mixtures made at intervals of 10% on a mass basis was investigated. The thermal characteristics of enthalpy and heat capacity values of the resultant phases were obtained using heat-flux DSC. From the preliminary analysis of the enthalpy data, it was found that the final values increased when

slower cooling rates were employed although, from the XRD experiments, only one polymorphic type is produced; such as ß? in the case of 5L5M mixture. One of the reasons could have been that the instrument computes the enthalpy as a function of the thermocouple temperature instead of the sample temperature. Therefore, further treatment of the data was performed in order to get accurate values. The ultimate aim of this work was to develop a model that predicts kinetic interaction parameters between two lipid components using more accurate and realistic enthalpy and heat capacity values. This allows to better understanding the crystallization process of these materials, which then can be extended to more complicated systems under static and shearing conditions.

Oil-water Emulsions of β-lactoglobulin Glycated with Glucose, Lactose, and Dextrane.
A. Medrano[1], C. Abirached[1], I. Vieitez[1], L. Panizzolo[1], P. Moyna[1], M. Añón[2], [1]Facultad de Química, Universidad de la República, Montevideo, Uruguay, [2]CIDCA, Universidad Nacional de La Plata, La Plata, Buenos Aires, Argentina

The creaming, flocculation and coalescence processes of destabilization of emulsions prepared with glycated β-lactoglobulin were analyzed. The glycation process was carried out with glucose, lactose and dextran (MW 1500 Da) in different reaction conditions (reaction time and protein:carbohydrate molar ratio). The glycation of β-lactoglobulin with carbohidrate causes an increase in the stability of oil-water emulsions. It was found that the process of creaming had a sigmoid behavior which fit to an equation with two parameters, one with hyperbolic and the other with sigmoidal kinetics and is directly related to particle size of the dispersed phase of the emulsion. β-lactoglobulin glycated with dextran emulsions showed greater stability to creaming than those prepared with β-lactoglobulin glycated with glucose and lactose, which was related to the decrease in the particle size of the dispersed phase and the increased concentration of protein at the interface of the emulsions. Flocculation and coalescence were not influenced by the glycation.

A Model for Viscous Heating in a Couette Cell Used in Rheo-XRD and Rheo-NMR Research of Crystallization of Triglycerides.
F.C. Wang, G. Mazzanti, Dept. of Process Engineering and Applied Science, Dalhousie University, Halifax, NS, Canada

This study developed a model to describe how the viscous heat is generated in a Couette cell used in Rheo-XRD and Rheo-NMR on crystallization of triglycerides. The model was tested using a standard rheological oil (Canon N1000). The temperature of the cooling fluid inlet and outlet as well as the mechanical power delivered to the oil by the rheometer were measured. The measurements were conducted in a temperature range of 10–70°C under shear rates at corresponding to rotational speeds between 0.1 and 50 rps. The shear rates corresponding to these rotation speeds were calculated taken into consideration the temperature dependence of the viscosity of the oil, as well as its thermal conductivity. As expected, there is no significant increase in the temperature of the oil at low shear rates, and the oil is almost isothermal. However at high shear rates, there is a high temperature gradient across the oil and consequently a considerable departure from the radial shear rate distribution compared to an isothermal oil. Also, when the holding temperature went higher than 50°C, the effect of viscous heating was not obvious as the viscosity of the oil decreased while the temperature went higher.

Rheology of Crystallization of Diluted Binary Mixtures of Triglycerides.
F.C. Wang, G. Mazzanti, Dept. of Process Engineering and Applied Science, Dalhousie University, Halifax, NS, Canada

This study is aimed at understanding the rheology of crystallization of diluted binary mixtures of triglycerides. At present, the study of fat crystallization under different shear rates has not been fully developed, however it is really important for food industry. Materials being analyzed in this study consisted of different ratio blends of trimyristin and trilaurin diluted in 60% of triolein. The temperatures of the cooling fluid inlet and outlet as well as the mechanical power delivered to the crystallizing mixture by the rheometer were measured. The measurements were conducted in a holding temperature range of 10–28°C under shear rates corresponding to rotational speeds 0.5rps, 5rps and 50 rps. Results shown, as expected, that generally the maximum mechanical power was delivered at the time point where maximum viscosity was reached for all the mixtures at different temperatures under different shear rates. In addition, as the holding temperature went higher, the maximum mechanical power decreased because of the decrease in viscosity. The time to reach the max power varied depend on the composition of the triglyceride mixtures at different holding temperatures under low shear rate. But the holding temperature has no significant effect on time to reach to max power at a high shear rate. There was no general trend of how the mechanical energy correlated to the temperature.

Mamey Sapote: Physical Characterisation and Applications after Fractionation.
Gilda Avendaño[1], Maria Fernanda Peyronel[2], Erasmo Herman[1], Cecilia Eugenia Martínez [1], Alejandro Marangoni[2], [1]Instituto Tecnologico de Tuxtepec, Tuxtepec, Oaxaca, Mexico, [2]Food Science Department, University of Guelph, Guelph, Ontario, Canada

Refined, neutralized and bleached cold pressed Mamey Sapote oil was successfully fractionated into olein and stearin. Acetone was used for the fractionation in a ratio 4:1 (w/w) solvent:oil, yielding 15 % stearin after 9 hours at 7 ºC. Physical analysis of the oil and fractions by DSC, GC, X-ray diffraction and PLM will be presented. DSC experiments showed similar melting points for the stearin and Cocoa Butter, as well as very similar fatty acid composition (11.93 % of 16:0, 40.14 % of 18:0, 38.61 % of 18:1, 7.64 % of 18:2 and 1.04 % of 18:3.). Powder XRD demonstrated an L3, beta five type polymorphic crystals, almost identical to that of cocoa butter suggesting that the stearin has the potential to be used in confectionaries products. GC results for olein showed a composition of 0.89 % 14:0, 9.56 % 16:0, 18.52 % C18:0, 53.83 % 18:1, 15.2 % 18:2 and 1.67 % 18:3. We also present results of melting points and hardness tests carried out on chocolate made with pure stearin from Mamey Sapote and from mixes of stearin and cocoa butter. An iso-solid diagram of stearin with CB showed a eutectic pattern which suggests the possibility of using this fat for truffles.

Time, Temperature, and Shear History Effects on the Kinetics of Polymorphic Transformations within a Monoglyceride Stabilized Oil-in-Water Emulsion.
Avi Goldstein, Alejandro Marangoni, Koushik Seetharaman, University of Guelph, Guelph, Ontario, Canada

Here we report on the effects of aging, temperature, and shear history on the polymorphism and

stability of structured monoglyceride stabilized oil-in-water emulsions, or MAG gels. Sheared and non-sheared samples were studied over 28 days storage at 20°C and 30°C. The formation of monoglyceride β crystals was accompanied by the expulsion of water from the crystal lattice. T2 relaxation times determined using proton pulsed Nuclear Magnetic Resonance (pNMR) allowed for the determination of water mobility within the gels. Monoglyceride crystal polymorphism was determined by powder X-ray Diffraction (XRD). Shear resulted in greater water mobility within MAG gels compared to non-sheared samples. Sheared gels exhibited greater mobility at lower storage temperatures. Shear resulted in sharper β polymorphic peaks (smaller full-width half maximum, or FWHM) than non-sheared MAG gel samples, with gels stored at elevated temperatures exhibiting faster kinetics of β polymorph formation. This study established a relationship between water mobility determined by T2 relaxation analysis and FWHM of β polymorph XRD reflections. This work demonstrates that increasing crystalline perfection in MAG gels leads to a decrease in the strength of water binding, and that shear enhances this process.

Thermal and Optical Properties of Mixed Pectin-wax Films.

E.R. Baümler[1], A.A. Carelli[1], S. Martini[2], [1]Planta Piloto de Ingeniería Química (PLAPIQUI), Universidad Nacional del Sur-Consejo Nacional de Investigaciones Científicas y Técnicas, Bahía Blanca, Argentina, [2]Department of Nutrition, Dietetics, and Food Sciences, Utah State University, Logan, UT, USA

Edible films are generally made from proteins, polysaccharides and lipids, used alone or together. The use of pectin has been proposed because it is edible and gives an attractive coating. Improved films are obtained with a multicomponent system where hydrocolloids form a continuous and cohesive network, and the hydrophobic substances provide the moisture barrier properties. The objective of this research was to develop composite biofilms produced using mixtures of low-methoxyl pectin and sunflower waxes, this material was included in film formulation in order to increase the water impermeability. Physical, thermal and optical properties were characterized. The film thickness, determined with a manual micrometer, showed an increment as the concentration of pectin increased. The measurement was influenced by the surface roughness. Polarized micrographs of the films showed marked differences in their microstructure. The addition of waxes caused a whitish color, a rough surface film and a light transmission reduction.Two melting endothermic peaks were observed by differential scanning calorimetry: The peak at 70-80°C region was assigned to the melting of waxes, while the other one was observed at temperatures above 100°C and belonged to moisture removal. The increase of pectin content caused a decrease in the waxes melting enthalpy; this might be caused by the inhibition of the growth of the wax crystals provoked by the pectin emulsifier effect.

The Shearing Effect on the Thermal and Rheological Properties of Candelilla Wax Organogels.

J.F. Toro-Vazquez, M. Chopin-Doroteo, J. Morales-Rueda, M.A. Charo-Alonso, E. Dibildox-Alvarado, Universidad Autonoma de San Luis Potosi, Facultad de Ciencias Quimicas-CIEP, San Luis Potosi, SLP, Mexico

A shear rate of 600 s^{-1} was applied during cooling (1°C/min) of 3% candelilla wax (CW) and 3% CW-1% tripalmitin (TP) solutions, until reaching nucleation (i.e., 47°C) or metastable conditions

(i.e., 52°C), then allowing gelation under quiescent conditions at 15°C. Under static conditions CW crystallized in an orthorhombic subcell packing and in the CW-TP system, TP co-crystallized with the CW components (i.e., hentriacontane) with the same orthorhombic structure modifying the melting properties of the CW organogels. The application of shearing did not modify the crystal packing or the melting properties of the organogels. However, shearing developed larger crystals and when shearing was applied until reaching metastable conditions (i.e., CW 52°C and CW-TP 52°C), the organogels showed the highest G′ and yield stress of all organogels investigated. Creep and recovery analysis showed that CW 52°C and CW-TP 52°C organogels had the highest resistance to deformation, lowest instantaneous recovery and highest extended recovery of all organogels studied. Then, shearing, and the extent of its application as a function of supercooling, determine crystal size and the proportion of transient to junction zones in the three-dimensional crystal network and, therefore, the organogels rheology.

Thermo-mechanical Properties of Amide Derivatives of Hydroxystearic Acid and Candelilla Wax Organogels.

J.F. Toro-Vazquez[1], J. Morales-Rueda[1], V. Ajay Mallia[2], R.G. Weiss[2], [1]Universidad Autonoma de San Luis Potosi, Facultad de Ciencias Quimicas-CIEP, San Luis Potosi, SLP, Mexico, [2]Georgetown University, 2Departments of Chemistry and Physics, Washington, DC, USA

The relationship between the molecular structure of (R)-12-hydroxyoctadecanamide (HOA), (R)-N-propyl-12-hydroxyoctadecanamide (P-HOA), (R)-N-octadecyl-12-hydroxyoctadecanamide (O-HOA), and candelilla wax (CW) with the thermo-mechanical properties of 2% organogels in safflower oil (HOSFO) was investigated using two cooling rates (1 and 20°C/min). Independent of the cooling rate, the amides provided organogels with higher melting temperature, heat of melting, and crystallization parameters, than CW. The rheological results indicated that the strenght of the organogels is associated with the nature of amide groups (i.e., primary or secondary amide), the increase in the length of the self-assembly molecular unit (i.e., L value determined by X-ray diffraction) and the cooling rate. Creep and recovery measurements showed that, independent of the hydrogen bonding and dipolar interaction provided by the amide and hydroxyl groups, the increase in the hydrocarbon chain length results in organogel with higher resistance to deformation and higher instant recovery capacity. However, the cooling rate applied affected the thermo-mechanical properties of the organogels. This effect was strongly dependent on the length of the self-assembly molecular unit.

Crystallization Behaviour of a Model Shortening with Low Saturated and Zero-trans Fatty Acids Studied by Rheo-XRD.

I. Ahmed[1], M. Li[1], F. Peyronel[2], N. Acevedo[2], G. Mazzanti[1], [1]Dalhousie University, Halifax, NS, Canada, [2]University of Guelph, Guelph, ON, Canada

The crystallization of a model shortening made from a blend of soybean oil (SO) and fully hydrogenated soybean oil FHSO has been studied using simultaneous in-situ time-resolved synchrotron x-ray diffraction and rheology. The blend, intended for baking laminates, has zero-trans and low level of saturated fatty acids. Samples containing different proportions of FHSO: SO (40:60 and 45:55 by weight) were crystallized from the melt at 70 °C under different shearing rates (0, 25, 200 and 800 s^{-1}). The crystallization was conducted by cooling down to three end temperatures (20, 10 and 1 °C) at a cooling rate of 15 °C/min. After the crystallization

time the samples were melted with a heating rate of 25 °C /min. Diffraction patterns were captured at 90s intervals during the crystallization and the melting. The rate of crystallization, polymorphic behaviour and phase distribution are reported as a function of the thermomechanical treatment of the sample. Application of shear had a very significant impact on the behaviour of the materials.

Regio-selective Enzymatic Interesterification Combined with Dry Fractionation to Produce CBE.

S. Danthine[1], S. VanDen Bossche[1], C. Blecker[1], J. Maes[2], V. Gibon[2], [1]University of Liege, GxABT, Gembloux, Belgium, [2]DeSmet Ballestra Group, Zaventem, Belgium

Specialty fats are widely used in the chocolate and confectionary industry in replacement of cocoa butter (CB). Several groups are commonly identified: CB equivalents (CBE), CB substitutes, and CB replacers. However, only CBE are fully compatible with CB. Regular CBE originate from illipe, shea butter stearin, sal stearin, kokum, mango stearin and hard palm mid fraction that need to be blended before use, in order to readjust the POP/POS /SOS content. Regio-selective enzymatic interesterification (EIE) is an alternative to tailor fats for the production of new types of CBE. In this study, a CBE was prepared by combining EIE and dry fractionation. A soft palm mid fraction (SPMF) and stearic acid were selected as raw materials, the objective being to produce a high POP/POS/SOS fat with a maximum of stearic acid in sn1-3positions. RM IM (immobilized lipase from Rhizomucor miehei, Novozymes) was used. Three SPMF/ stearic acid ratios were investigated. Optimal conditions were determined at lab scale, using a batch reactor; the reaction was followed during 32h. TAG composition of the EIE products was determined by HPLC; melting properties were determined by DSC and p-NMR. The optimized lab scale conditions were extended to pilot scale. Compositional and melting characteristics of the so-obtained CBE will be presented.

Crystallization Mechanisms of Cream during Butter Manufacturing.

P. Buldo, L. Wiking, Aarhus University, Tjele, Denmark

The final physical and sensorial characteristics of butter and butter blends are mainly determined by solid fat content and microstructure, thus by the crystal network formed during production processes. Crystal network formation is influenced by the processing parameters used and by the fatty acid composition. In this study different temperature treatments for conventional and organic cream were investigated in order to study the mechanisms of cream crystallization, such as level of solid fat content, butter grain size and fractionated crystallization and to determine the factors influencing the churning time. Crystallization mechanisms were studied as function of time by oscillation rheology and by differential scanning calorimeter, whereas microstructure was investigated by oscillation rheology and particle size distributions.Oscillatory measurements are used to detect partial coalescence occurring during butter manufacturing. Moreover, the crystallization process, such as crystal growth and their network building, is followed. The obtained results showed that a combination of different methods can be used to investigate and follow the crystallization behavior of the complex fat system and also to gain information on the crystal network, thus on the final macroscopic properties of butter.

Physical Characteristics of Sunflower Wax-pectin Aqueous Solutions.

E.R. Baümler[1], R. Kerr[2], A.A. Carelli[1], S. Martini[2], [1]Planta Piloto de Ingeniería Química (PLAPIQUI), Universidad Nacional del Sur-Consejo Nacional de Investigaciones Científicas y Técnicas, Bahía Blanca, Argentina, [2]Department of Nutrition, Dietetics, and Food Sciences, Utah State University, Logan, UT, USA

The aim of this study is to investigate some physical properties of emulsion pectin solutions containing sunflower wax, which are used as a basis for producing edible films. These films have long been used as an alternative to synthetic packing to prevent moisture migration between food and their environment. Rheological and optical characteristics of pectin aqueous solutions containing sunflower waxes were considered. The presence of wax crystals in the pectin solutions was observed using a polarized light microscope. The size of these crystals decreased as pectin concentration increased. This may be due to the emulsion stabilizing properties of pectin. The use of different rheological models to describe the viscoelastic behavior of pectin emulsion solutions was examined. Samples exhibited a non-Newtonian liquid behavior, which was best described by means of Herschel-Buckley model. Apparent viscosities were determined using this model, which increased with pectin content in the emulsion. When sunflower waxes were added the apparent viscosity in the emulsions decreased. The characterization of these solutions are useful to optimize the production of pectin-wax-based emulsion coatings to prolong the shelf-life of food products.

Formulation of Submicron Emulsions with DHA Located Either at the Interface or in the Bulk Oil.

T.H. Kabri[2,1], A. Meynier[1], M. Linder[2], C. Genot[1], [1]INRA UR1268 Biopolymers Interactions Assemblies, Nantes, France, [2]INPL, LIBio, Nancy, France

To prevent prevalence of metabolic disorders associated to excessive intake of fat, recommandations are to reduce consumption of saturated fat and to increase the intake of long-chain polyunsaturated fatty acids (lc-PUFA omega 3). These PUFA can be esterified either in of triglycerides or phospholipids., being therefore in different environments that may impact their bioavailability or oxidative stability. The objective of this study was to formulate two emulsions with similar fatty acid profiles, where the lc-PUFA will be located either in the bulk phase or at the surface of the lipid droplets. Several vegetable, marine oils and lecithins were analysed and selected. Their fatty acid compositions were used to predict the composition of two lipid blends. The mixes present FA profiles that agree with the latest recommendations of the French Agency and allow to produce emulsions in which lc-PUFA are esterified on triglyceride or on phospholipid structures. The stability of the emulsions, that were prepared with high pressure homogenizer (2000 bars) and exhibited an average diameter of around 170 nm, was studied. Monitoring the kinetics of oxidation of these emulsions will highlight the influence of the location of n-3 PUFA on the course of oxidative processes.This work is carried out within the project AGEcaninox, ANR-08-ALIA-002

Developing a Polysaccharide-lipid Based Edible Coating Formulation to Reduce Weight Loss and Delay Ripening Process of Berangan Banana (Musa sapientum cv. Berangan).

Hoda Jafarizadeh Malmiri[1], Azizah Osman[1], Chin Ping Tan[2], Russly Abdul Rahman[2], [1]Department of Food Science, Faculty of Food Science and Technology, Universiti Putra Malaysia, Serdang 43400, Selangor, Malaysia, [2]Department of Food Technology, Faculty of

Food Science and Technology, Universiti Putra Malaysia, Serdang 43400, Selangor, Malaysia

Coating fruits with an edible film is an effective storage method to decrease rate of metabolic processes and extension shelf life. The individual and interactive effects of hydroxypropyl methylcellulose (2-6% w/v) and stearic acid (0-2% w/v) in combination with glycerol (1% w/v) on weight loss, peel colour, pulp firmness and total soluble solids content of Berangan banana (Musa sapientum cv. Berangan) were investigated using response surface methodology. The results obtained show that the experimental data could be adequately fitted into a second-order polynomial model with high coefficient of determination values ranging from 0.882 to 0.978 for all the variables studied. The main effect of hydroxypropyl methylcellulose concentration appeared to be the most significant ($P \leq 0.1$) factor influencing all variables studied and should be considered as a critical variable in edible coating formulation. The optimum concentration of hydroxypropyl methylcellulose and stearic acid were predicted to be 4.98 % and 1.12 %, respectively. Statistical assessment indicated insignificant ($P>0.1$) difference between experimental and predicted values of the physico-chemical characteristics of coated banana after day 10 of storage at ambient conditions.

Factors Affecting Oil Color Change during Frying.

K. Lazarick, R. Przybylski, University of Lethbridge, Lethbridge, Alberta, Canada

Darkening of oil during frying is often used as indicator of quality and fry-life of frying oil. Effect of individual food ingredients was analyzed during frying on pigments, polar components including 4-hydroxynonenal (HNE) formation. Among components analyzed, proteins stimulated formation of pigments at the fastest rate followed by carbohydrates. Oil oxidative degradation products more efficiently stimulated color changes than both proteins and carbohydrates. Next in the pigments formation were combinations between macro food ingredients and oxidized oils. Among frying parameters, temperature the most effectively increased rate of pigments formation. Also ratio between oil surface and volume significantly affected changes in frying oil color. HNE formation followed pattern of oil color changes, observing the highest amounts at the elevated frying temperatures and when oxidized oils was part of testing system. This data verifying a notion that changes in the frying oil can not be used as effective indicator of fried food quality and discarding point for the frying oil.

Melting and Solidification Properties of Palm-Based Diacylglycerol, Palm Kernel Olein and Sunflower Oil in the Preparation of Palm-Based Diacylglycerol-Enriched Soft Tub Margarine.

A.H. Saberi[1], L. Oi-Ming[1,2], [1]Dept. of Bioprocess Technology, Faculty of Biotechnology and Biomolecular Sciences, University Putra Malaysia, Malaysia, [2]Institute of Bioscience, University Putra Malaysia, Malaysia

Many studies have been conducted to deliver more healthy alternatives to full fat products. Incorporation of high proportion of diacylglycerol oil as a functional oil in to the plastic fat products through development of blend formulation is considered as one such attempt. Ternary mixtures containing sunflower oil (SFO), palm kernel olein (PKOL) and palm based diacylglycerol oil (POL-DAG) with certain proportions were designed using mixture design. The corresponding physical properties such as solid fat content (SFC) as well as deviation from SFC

(ΔSFC) using nuclear magnetic resonance (NMR) and melting and crystallization properties using differential scanning calorimetry (DSC) were studied. Ternary phase behaviour was analyzed with isosolid diagrams. The eutectic behaviour was observed along the binary line of PKOL/POL-DAG at temperature ranges of 5-20°C. This was reflected in the lower heat of crystallization (ΔHc) as well as higher ΔSFC for 50/50 mixture of PKOL and POL-DAG in contrast with PKOL and POL-DAG. No eutectic interaction was observed along the binary lines of SFO/PKOL as well as SFO/POL-DAG despite showing ΔSFC within temperature ranges of 5-25°C. Palm-based DAG-enriched soft tub margarine (PDAG-TM) containing SFO/PKOL/POL-DAG (35/15/50, (w/w)) was optimally formulated through analysis of multiple isosolid diagrams, and was found to have quite similar SFC profile as well as SMP but also lower saturated fatty acid as compared to the commercial soft tub margarine.

Concentration of Tocols from Rice Germ Oil by Supercritical Carbon Dioxide.

S.-N. Ko[1], T.-Y. Ha[2], S.I. Hong[1], I.-H. Kim[1], [1]Department of Food and Nutrition, Korea University, Seoul, Republic of Korea, [2]Korea Food Research Institute, Sungnam, Republic of Korea

An efficient process was developed for concentration of tocols from rice germ oil (RGO) by supercritical carbon dioxide (SC-CO_2). In this study, it was possible to concentrate tocols from RGO using SC-CO_2 at relatively low pressure. To efficiently concentrate tocols, the RGO was converted to the esterified RGO using sodium methoxide because the solubility of fatty acid methyl ester (FAME) in SC-CO_2 is much higher than that of triacylglycerol. Consequently, tocols was efficiently concentrated in residue by removal of FAME from the esterified RGO using SC-CO_2. The concentration of tocols was carried out at an operating pressure of 12.4-15.8 MPa, an operating temperature of 40-60 ºC, and flow rate of carbon dioxide of 5.0 L/min. The optimal pressure and temperature to concentrate tocols from esterified RGO were 13.8 MPa, and 60 ºC. The level of tocols in residue obtained at the optimal condition was 1270 mg/100 g residue, which implies a tocols enrichment of more than 6 times the initial tocols levels (192 mg/100 g) in the raw material, namely esterified RGO. There were no significant differences in relative percentage of tocols homologues between esterified RGO and residue obtained by SC-CO_2 extraction.

Synchrotron XRD Study of Crystallization Behavior of Diluted Binary Mixtures Under Shear.

M. Li, G. Mazzanti, I. Ahmed, E. McDade, Dalhousie University, Halifax, NS, Canada

Polymorphism of triglycerides (TAGs) has been elucidated at a molecular level for pure systems. The next step in approaching multicomponent systems is to study the binary systems of major TAGs. Binary mixtures of trilaurin (LLL) and trimyristin (MMM) were prepared with LLL: MMM ratios of 70:30, 50:50, and 30:70 w/w. The mixtures were diluted in triolein to 40, 60 or 80% w/w. Pure diluted LLL and MMM were also studied. Samples were cooled at 10˚C/min from the melt at 60˚C down to crystallization temperatures between 10 and 30˚C, and allowed to crystallize either statically or under shear rates of 800, 80, and $8s^{-1}$. Obvious phase transition acceleration was obtained from the experiments under shear. The binary mixtures preferred to form a phase with a 3.55nm d-spacing value rather than phase separate into LLL and MMM, so we believe they form a compound nanostructure. All the samples with LLL in it also form a β

phase with a d-spacing of 3.16 nm, not observed in pure MMM. Shear flow affected the polymorphism and phase distribution of the fats. A tightly packed β phase of LLL with a d-spacing value of 3.12 nm was only found from experiments under high shear.

Degradation, Characterization and Evaluation of Aflatoxin-B1 Fragments.

Pallavi Kundavaram[1], Yuanrong Jiang[1], Min Zhang[1], Shuhua Xia[1], Hong Yang[1], Xuebing Xu[1,2], [1]Wilmar Biotechnology Research and Development Center co., Ltd, Pudong New District,Shanghai,China, [2]Aarhus University, Gustav Wieds Vej 10C,Aarhus,Denmark

Aflatoxin-B1 (AFB1) is a potent toxic, carcinogenic, mutagenic and immunosuppressive agent. Aflatoxins (AFT) contamination in grain poses a great threat to human. For peanut oil (PNO) in China and European Union the limit of AFB1 is 20 and 8ppb, respectively. UV degradation is one of the best method for the degradation of AFT in PNO. We have been used an equipment (Patent No CN 201303576Y), to remove AFT, however, flavor and quality of edible oil (PNO) does not change. AFB1 standard sample was dissolved in chloroform and irradiated and fragments were separated by using column chromatography and analyzed by mass spectroscopy. This paper will discuss the degraded products and their toxic nature. The AFT content of original PNO from factory was 9.06ppb. The PNO had been UV irradiated at 365 nm for 1h. Then the AFT content of the sample was under below detection level in degraded samples, viz. 0.3 ppb for B1 and G1 and 0.2ppb for B2 and G2. The toxicity test and thirty days feeding study have been done for the AFT decomposition products. In summary, the degraded products are less toxic compared to AFB1. Furthermore, after UV degradation the quality of PNO didn't change and proved to be safe, which was confirmed by animal test.

Effects of Chemical Interesterification on Physicochemical Properties of Blends of Palm Stearin, Coconut Oil, and Canola Oil.

F.A.S.D.M Soares, R.C da Silva, M. Hazzan, E. Radduan, M.I. Gonçalves, L.A. Gioielli, University of São Paulo, São Paulo, São Paulo, Brazil

Blending and chemical interesterification of fats have been used to modify physical and chemical properties of natural fats. Palm stearin, coconut oil and canola oil were used as substrates for chemical interesterification. The main goal of this research is to evaluate the effects of chemical interesterification on physicochemical properties of blends of palm stearin, coconut oil and canola oil. Fat blends, formulated by binary and ternary blends of palm stearin, coconut oil and canola oil were done in different proportions. Triacylglycerol and fatty acid compositions, regiospecific distribution of triacylglycerols, consistency, melting and softening point, solid fat content, and melting and crystallization behavior by differential scanning calorimetry of the original and interesterified blends were evaluated. Results showed that chemical interesterification of palm stearin with coconut oil and canola oil offers a useful tool for the design of fats with tunable physicochemical properties, improved with respect to that of the starting fats.

Effect of Combination of Emulsifiers on the Crystallization of Low *trans* / Low Sat Fat.

Maria Aliciane Fontenele Domingues[1], Rita de Kássia Almeida Garcia[1], Ana Paula Badan Ribeiro[2], Lireny A. Guaraldo Gonçalves[1], [1]Faculdade de Engenharia de Alimentos/ Universidade Estadual de Campinas-UNICAMP, Campinas/São Paulo/Brasil, [2]Faculdade de Engenharia

Química/ Universidade Estadual de Campinas-UNICAMP, Campinas/São Paulo/Brasil

This work aimed to study the adequacy of low trans/low sat structured fats, obtained by blending palm oil and soybean oil (40%), with addition of two different structuring agents: soybean lecithin and sorbitan tristearate, in the levels of 1%, 3% and 5%, with ratios of 25:75, 50:50 and 75:25. Blends with different proportions of emulsifiers were compared with the control sample (without emulsifiers) and analyzed and compared separately, according to the total emulsifier content. The blends were analyzed as for the crystallization behavior through isothermal crystallization by NMR, fatty acid composition and triacylglycerol composition. In general, the blends with additives showed a reduction in maximum SFC in relation to the control sample, which is possibly associated with changes in the crystallization behavior and morphology of crystals formed by the use of these emulsifiers. Blends containing 3% and 5% of emulsifiers exhibit faster crystallization than the blends with 1% of additives. However, the different proportions of emulsifiers studied did not influence the crystallization behavior of the blends, resulting in similar curves at the same additive content. The predominant fatty acids in the blends were, respectively, C16:0, C18:1, C18:2. The evaluated blend presented low levels of trisaturated triacylglycerols, as well as a P/Sat ratio equal to 0.58.

Effect of Processing Conditions and Stabilizer Components on Physicochemical and Stability Properties of Astaxanthin Nanodispersions.

N. Anarjan[1], C.P. Tan[1], H. Mirhosseini[1], B. Sham Baharin[1], H. Jafarizadeh Malmiri[2], [1]Department of Food Technology, Faculty of Food Science and Technology, Universiti Putra Malaysia, Serdang, Selangor, Malaysia, [2]Department of Food Science, Faculty of Food Science and Technology, Universiti Putra Malaysia, Serdang, Selangor, Malaysia

Central composite design was employed to study the effect of homogenization and evaporation parameters on particle size distribution and astaxanthin loss of produced astaxanthin nanodispersions via emulsification-evaporation method. These parameters were homogenization pressure (300-700MPa) and number of cycles (1-5), evaporation time (2-22 min), temperature (21-74°C) and rotating speed (0-200 rpm). The optimum processing conditions were obtained using homogenization at 500 MPa for 2 passes and evaporation parameters of 35°C, 11 min and 120 rpm. Under these optimum processing conditions, a simplex centroid mixture design was also used to study the interactions among three stabilizer components, namely pectin, sodium caseinate and sucrose oleate, as an emulsifying system in the formation of astaxanthin nanodispersions. The initial particle size, astaxanthin loss and the percentage of physicochemical changes after one month of storage were determined. The multiple-response optimization predicted that using 44% sucrose oleate, 10% pectin and 46% sodium caseinate in emulsifier mixture, provided astaxanthin nanodispersions with minimum particle size (72.7nm), astaxanthin loss in freshly prepared sample (6.5%) and changes in particle size (9.2%) and astaxanthin loss during storage (32.3%).