2009 Annual Meeting Abstracts

MONDAY

MORNING
EAT 1: Emulsions and Dispersed Systems
Chair(s): P. Rousset, Nestec SA, Switzerland; and A. Wright, University of Guelph, Canada

Synchrotron X-ray Microbeam Analysis of Fat Crystallization in O/W Emulsions using Different Emulsifiers. Kiyotaka Sato[1], Satoshi Arima[2], Akihiro Ogawa[2], Satoru Ueno[1], [1]Hiroshima University, Higashi-Hiroshima, Hiroshima, Japan, [2]Mitsubishi Chemical Co., Yokohama, Kanagawa, Japan

We have observed the crystallization behavior of fats in oil-in-water emulsion droplets by using synchrotron X-ray microbeam technique. The effects of the emulsifiers on interfacial heterogeneous nucleation in the emulsion droplets were examined for two cases; the crystallization of n-alkane with different Tween series of emulsifiers, and the crystallization of palm-mid-fraction with Tween 20 and sucrose fatty acid esters employed as the additive. In the former case, the use of Tween 80 did not cause the interfacial crystallization, whereas the Tweens having saturated fatty acid moieties caused the interfacial crystallization. In the latter case, the addition of the sucrose fatty acid ester having palmitic acid moiety caused the interfacial heterogeneous nucleation. We found that the emulsifiers having high-melting fatty acid moieties caused interfacial heterogeneous nucleation through hydrophobic interactions at the oil-water interfaces in the emulsion. Also, the arrangements of fat crystals are also influenced by the interfacial nucleation in a way that the lamellar planes of fat crystals are parallel to the oil-water interface.

Self-assembly in Emulsions. Laurent Sagalowicz, Nestlé Research Center, Vers-Chez-Les-Blanc CH-1000 Lausanne 26, Switzerland

One challenge in the development of functional foods is to guarantee the efficacy of a given bioactive compound incorporated in the food matrix. The poor solubility or the fast degradation in aqueous system is a barrier, which needs to be overtaken. Therefore appropriate delivery systems need to be used since classical encapsulation techniques, like spray-drying, are not adapted to liquids. One way to introduce active elements in liquid products or emulsions is to use self assembly concepts. For example, amphiphilic molecules, such as monoglycerides and phospholipids, form spontaneously self-assembly structures, when they are mixed with water. These self-assembly structures incorporate (solubilize) spontaneously active elements of various physico-chemical characteristics.In the present contribution we will compare various delivery systems and see their advantage and their limitations and how they can be introduced in emulsions. We will mainly focus on lipid self assembly structures. Potential new functionalities of these systems will be described.

Synchrotron Radiation Microbeam X-ray Diffraction Study for Whipped Oil with High-Melting Fats: Evidence of Adsorption of Fat Crystals at Air-Oil Surfaces. S. Ueno, S. Mishima, A. Suzuki, K. Sato, Hiroshima University, Higashi-Hiroshima, Hiroshima, Japan

We have observed that, without any emulsifiers, whipped oil was formed by stirring liquid oils (camellia oil, macadamia nut oil, high oleic sunflower oil, olive oil and soybean/rapeseed oil) containing high-melting fat (fully-hydrogenated rapeseed oil with behenic acid: FHR-B) crystals. DSC, polarized microscopy, FT-IR and synchrotron radiation microbeam X-ray diffraction (SR-micro-XRD) were employed to observe crystallization and melting of FHR-B crystals and their adsorption properties at the air-oil surfaces. We found that whippability and stability of the whipped oil depended on melting point of liquid oil, concentration of FHR-B crystal and its polymorphism, tempering process, stirring time and storage temperature. In particular, the adsorption of the FHR-B crystals was indicated with FT-IR and SR-micro-XRD in such manners that the quantity of fat crystals in dispersed liquid oil decreased by increasing the stirring time due to absorption at the air-oil surface, and the SR-micro-XRD patterns from the FHR-B crystals around an air cell showed oriented adsorption at the air-oil surface.

Production and Formulation of W/O Emulsions and Peanut Dispersions with Probiotic Cultures. P. Wassell[1], M. Farmer[1], J. Nedderson[2], [1]Danisco A/S, Brabrand, Aarhus, Denmark, [2]Danisco USA, USA

Incorporation of probiotics into spread formulations is fraught with difficulties, because of harsh processing conditions. Typically, the probiotic species is incorporated into the emulsion via a water phase, which is possibly pre-pasteurized, alongside other water phase components. Emulsion temperature must not denature the probiotic. Deep cooling and scraping actions within the tubular Scraped Surface Heat Exchangers can cause damage to the probiotic cell counts by as much as 50%. Viable survival rates can hinge on water droplet size during processing, however, this approach can compromise emulsion stability, hence shelf life, and quality.Freeze-dried probiotics can be introduced directly into the the oil continuous phase during final stage of mixing, where typical exit temperatures of 10-20°C are desirable. Using a liquid delivery system, consisting of a suspension of concentrated probiotics is found practical for producing pilot scale probiotic spreads, achieving on the day of production contains about 10^8-10^9 cfu/g (colony forming units/gram of product) and wherein about 10^6-10^7 cfu/g lactic acid micro-organisms remain viable about 12 weeks after the day of production.Discussion will explain how it is possible to achieve viable probiotic w/o products using conventional process, and also show viable counts obtained from probiotic peanut butters.

Pickering vs. Network Stabilization of Water-in-Oil Emulsions. Supratim Ghosh, Tu Tran, Dérick Rousseau, Department of Chemistry and Biology, Ryerson University, Toronto, Ontario, Canada

It is demonstrated that water-in-oil emulsions may be stabilized by interfacial (Pickering) crystals and/or a fat crystal network, depending on post-homogenization cooling conditions. Model emulsions made with 20% (w/w) water, canola oil and a stabilizing fat were homogenized at 80°C and cooled either slowly or rapidly to 25°C, and stored for 7 days. Glycerolmonostearate (GMS) added to the oil phase crystallized at the surface of the dispersed droplets, resulting in Pickering stabilization. For network stabilization, glycerolmonooleate (GMO) and hydrogenated canola oil (HCO) were added to the oil phase. The addition of GMS and HCO to the oil phase was used to investigate combined Pickering and network stabilization. All emulsions were characterized by examining their sedimentation, thermal properties, microstructure and dispersed phase droplet size. With fast cooling there were no changes in sedimentation nor droplet size evolution for any of the emulsions. With slow cooling, however, only the GMS/HCO-stabilized emulsions remained stable to sedimentation. Temperature-cycling with DSC was used to isolate the contribution of Pickering vs. network stabilization, and showed that both GMS and GMO alone in the liquid state were ineffective stabilizers. Stabilization mechanisms were further analyzed with oil/water/crystal contact angle measurements and crystal surface energetics.

Presence of Dispersed Aqueous Phase Strongly Influence Rheology and Microstructure of Crystalline Network. Supratim Ghosh, Roomana Aafaqi, Dérick Rousseau, Department of Chemistry and Biology, Ryerson University, Toronto, Ontario, Canada

The effect of a dispersed aqueous phase on the microstructure and rheology of wax-mineral oil mixtures was evaluated. Addition of 3 or 5% (w/w) wax in mineral oil resulted in non-Newtonian flow behavior only when the molten wax crystallized. Addition and emulsification of an aqueous phase (20% w/w) aided by polyglycerol polyricinoleate increased overall viscosity by a factor of two. Based on microscopy of the emulsion, the wax crystal network and discrete, but aggregated water droplets behaved as a bicontinuous network. Viscoelasticity temperature sweeps of the oil+wax network and emulsion were performed from 40°C to 4°C. Upon wax crystallization (~30°C), there was an increase in both storage moduli (G′) and loss moduli (G″), until a crossover temperature was reached, at which point G′ dominated over G″. The gelation temperature of the oil+wax network was lower than that of its emulsified counterpart, which suggested that the dispersed phase was accelerating wax crystallization. An increase in gelation temperature was also noted with lower cooling rates, demonstrating the impact of nucleation and growth processes on rheology. Overall, this study demonstrated that the presence of a dispersed phase and/or wax significantly affected the microstructure and rheology of this model system.

Emulsifiers for Coffee Whitener. Niels Barfod, Annette Tjornelund Jensen, Danisco, Brabrand, Denmark

Standard emulsifiers used for production of powdered coffee whiteners (PCW) are monoglycerides (MG) and

diacetylated tartaric esters of monoglycerides (DATEM). A study was undertaken to investigate the effect of dosage and types of MGs and DATEMs. Two types of MG were studied, fully saturated MG (sMG) and partially unsaturated MG (uMG). Three types of DATEMs varying in tartaric acid content were studied. The effect of adding soap (Na Stearate) was also studied. The functionality of the produced PCWs was evaluated by 1) particle size distribution analysis of the powders diluted in hot water using laser light scattering technique and 2) whitening effect in coffee analysed by an image analysis based on multispectral illumination combined with chemometric analysis. The basic recipe contained: Fat (partially hydrogenated palm oil) 35-36%, Glucose syrup 59-60%, Buffer salt (K2HPO4) 1.75%, Na-Caseinate 2.7%, DATEM 0.05-0.2%, MG 0.2-1.0%. The ratio of water:dry ingredients was 3:7 in all trials. The emulsions were homogenised, pasteurised and spray dried using a high pressure nozzle. The uMG appeared to be superior to sMG and the optimal concentration appeared rather low, 0.4-0.5%. Higher dosages of sMG gave inferior results. A DATEM with rather low tartaric acid content appeared to be the best, the optimal concentration being 0.1%. Addition of soap had only a small positive effect on functionality.

Effect of Cooling Rate on the Stability of Anhydrous Milk Fat/Soybean Oil-in-Water Emulsions. M. Tippetts, S. Martini, Utah State University, Logan, UT, USA

The effect of cooling rate on the stability of oil-in-water (o/w) emulsions was studied as a function of formulation (20% and 40% o/w), homogenization conditions, and crystallization temperatures (Tc =10, 5, 0, -5 and -10 °C). The lipid phase was equal parts anhydrous milk fat and soybean oil. The emulsifier was whey protein isolate (1.8% protein). The analysis of crystallization and melting behaviors was done using differential scanning calorimetry; while the physicochemical stability was measured by a vertical scan macroscopic analyzer. Initially, with a fast cooling rate emulsions formulated with 20% oil were less stable that the ones formulated with 40% oil; however, by slowing the cooling rate the stability of emulsions increased for 20% o/w. In addition, slow cooling promoted the onset of crystallization and delayed crystal growth. These effects were more significant in emulsions formulated with 20% oil and with bigger droplets. These same conditions (slow cooling rates in emulsions with bigger droplets) resulted in less fractionation of the lipid network formed indicating that this lack of re-organization of the triacylglycerides molecules might be responsible for the increased stability of the emulsion.

AFTERNOON
EAT 2: Nano Liquids and Solids
Chair(s): N. Garti, Hebrew University of Jerusalem, Israel; and S. Narine, University of Alberta, Canada

Lyotropic Liquid Crystals: from Fundamentals to Applications. Raffaele Mezzenga[1,2], [1]University of Fribourg, Fribourg, Switzerland, [2]Nestlé Research Center, Lausanne, Switzerland

Lyotropic liquid crystalline phases in foods, such as those based on lipids, water and hydrophilic or hydrophobic low molecular weight compounds, constitute a perfect and rare example of a complex food system at thermodynamic equilibrium. They also offer an ideal and a model system to study relaxation mechanisms of oil-water interfaces with complex topologies having periodical order at the nm- length scales. The static structural features of self-assembled lyotropic liquid crystalline phases can be then successfully described by well established thermodynamic theories such as the self-consistent field theory (SCFT), suitably modified to account for hydrogen bonding interactions. At the same time, their complex rheological behaviour can be studied by resolving the relaxation spectra from experimental frequency scan curves. In the present talk, I will discuss how the understanding of the structural and dynamic properties of these self-assembled mesophases can contribute to the use of these systems in real applications such as delivery systems for active ingredients.

Crystallizing Membrane Proteins in Lipidic Mesophases for Use in Macromolecular Crystallography. M. Caffrey, University of Limerick, Castletry, Limerick, Ireland

One of the primary impasses on the route that eventually leads to membrane protein structure through to activity and function is found at the crystal production stage. Diffraction quality crystals, with which structure is determined, are particularly difficult to prepare currently when a membrane source is used. The reason for this is our limited ability to

manipulate proteins with hydrophobic/amphipathic surfaces that are usually enveloped with membrane lipid. More often than not, the protein gets trapped as an intractable aggregate in its watery course from membrane to crystal. As a result, access to the structure and thus function of tens of thousands of membrane proteins is limited. In contrast, a veritable cornucopia of soluble proteins have offered up their structure and valuable insight into function, reflecting the relative ease with which they are crystallized. There exists therefore an enormous need for new ways of producing crystals of membrane proteins. One such promising approach makes use of lipidic liquid crystalline phases (mesophases). In my presentation, I will describe the method, our progress in understanding how it works and recent community-wide advances in applying the method for membrane protein structure determination.

Solubilization of Lysosyme in Modified Novel Reverse Hexagonal Mesophases. N. Garti, T. Mishraki, I. Yuli-Amar, D. Libster, The Hebrew University of Jerusalem, Jerusalem, Israel

Mixtures of water and glycerol monooleate (GMO) from a variety of structured mesophases such as lamellar, hexagonal and cubic. However, these systems are difficult to utilize in food systems mainly because of their high viscosities. We learned to form a ternary phase diagrams with cosolvents modulating the headgroups of the GMO and/or its tails causing slight disorder in the mesophases and making them fluid.The novel mesophases have larger water channel diameters, larger lattice parameter and longer channels. In this work we will present methods to modify the hexagonal mesophases, new analytical tools to analyze their structural modifications and will demonstrate how a relatively large molecule such as lysozyme of 14 KDa can be easily entrapped and intercalated within the water channels even when the channels are smaller than the protein gyration radius.Structural and molecular interactions of the protein with the GMO will also be discussed.

Small-angle X-ray and Neutron Scattering of Nanostructured Monoacylglycerol Lipid/Water Self-assemblies. A. Angelova[1,2], B. Angelov[3,4], V.M. Garamus[4], S. Lesieur[1,2], U. Vainio[5], S.S. Funari[5], R. Willumeit[4], P. Couvreur[1,2], [1]CNRS UMR 8612 Phisico-chimie, Pharmacotechnie, Biopharmacie, Chatenay-Malabry, France, [2]University Paris Sud, Chatenay-Malabry, France, [3]Institute of Biophysics, Bulgarian Academy of Sciences, Sofia, Bulgaria, [4]Institute of Materials Research, GKSS Research Center, Geesthacht, Germany, [5]HASYLAB - DESY, Hamburg, Germany

Towards nanotechnology advances, self-assembled lipid/water systems formed by functionalized monoglyceride mixtures are investigated by means of small-angle X-ray (SAXS) and neutron scattering (SANS). Glycerol monooleate bilayer, which is a building block of the soft-matter nanostructured materials, can exist in both crystalline and fluid forms. In excess water, it constitutes cubic liquid crystalline phases that present structural advantages as nanostructured delivery carriers of therapeutic and nutraceutic molecules and as templates for membrane protein crystallization. Such highly-ordered periodic structures are characterized by a constant interfacial monolayer curvature of the curved lipid bilayer and bicontinuous aqueous nanochannel architecture. Recently, it has been shown that inhomogeneous distribution or phase separation in the fluid multicomponent lipid membranes could cause structural transformations to intermediate nonlamellar phases or to continuous bilayer phases of nonuniform interfacial curvature. Our work has focused on modulation of the sizes of the aqueous nanocompartments, present in the lipid supramolecular structures, by incorporation of a hydration enhancement agent. References: Angelov B. et al., J. Am. Chem. Soc., 2007, 129, 13474.; ibid, 2006, 128, 5813-5817.

TUESDAY

AFTERNOON
EAT 3: Crystallization
Chair(s): S. Narine, University of Alberta, Canada; and F. Kincs, Retired, USA

The Effect of Different Types of Triglycerides on Microstructural and Macroscopic Properties of Fats Used in Confectionery Coatings. J. Vereecken[1], K.W. Smith[2], K. Dewettinck[1], [1]Ghent University, Ghent, Belgium, [2]Unilever Research Colworth, Sharnbrook, Bedfordshire, UK

There is a drive in the market to reduce trans fatty acids from food products due to their perceived negative impact on health. The physical functionality of trans fatty acid containing fats, like e.g. coating fats, is greatly dependent on the amount of trans fatty acids present, which are required to produce solid fat. However, the only alternative to trans fatty acids, with respect to forming solid fat, is saturated fatty acids. The structure provided in any fat by the solid fat is not only dependent on the amount present but also on the type of crystals and their interaction with each other. Additionally, the arrangement of the fatty acids on the glycerol backbone can be important. In this study we examine the effect, on the crystallisation and structure, of changing the triglyceride composition in blends with the same overall saturated fat content. Crystallization properties were studied by SFC, DSC and polarized light microscopy. Macroscopic properties were compared by hardness measurements. Aside from the anticipated effects (i.e. greater levels of trisaturated TAG lead to faster crystallisation), the results demonstrated the big difference between palmitic based and stearic based blends. Also interesterification seems to play a big role in the final structure development.

Rheological Properties of Edible Organogels Measured in a "True Gap" System. J.F. Toro-Vazquez, J.A. Morales-Rueda, M.A. Charo-Alonso, E. Dibildox-Alvarado, Universidad Autónoma de San Luis Potosi, San Luis Potosi, SLP, Mexico

The rheology of organogels developed by candelilla wax (CW) and a pure n-alkane (dotriacontane, C32) was evaluated in a rheometer equipped with a "true-gap" system. This device makes the corrections in gap size associated with the expansion/shrinkage of the sample and/or the rheometer geometry, when changing temperature conditions are used. The liquid phase used was safflower oil (SFO) and the treatments studied resulted from the factorial combinations of two levels of gelator concentration (1% and 3%), cooling rates of 1°C/min and 10°C/min, and two gel setting temperatures, 5°C and 25°C (Tset). The elastic modulus (G') was measured as a function of time and the G'_0 (time = 0 min) and G'_f (time = 180 min) plotted as a function of the solid phase content (SPC). At 1°C/min in both the CW and C32 organogels, G'_0 and G'_f increased exponentially as a function of SPC. However, at 10°C/min the increase in G'_0 and G'_f was quadratic achieving a plateau. No significative difference between G'_0 and G'_f was observed as with the 10°C/min measurements obtained with a rheometer without the true-gap system. The use of the true-gap system provided rheological parameters that agreed with the micro structure and calorimetric behavior of the organogels.

Rheo-NMR Characterization of Crystallizing Fats. M. Li, G. Mazzanti, Dalhousie University, Halifax, NS, Canada

ABSTRACT The properties of crystallized fats depend on their solid fat content (SFC) and their fractal structures, which are affected by shear during crystallization. Binary mixtures of pure triglycerides in a non-crystallizing oil (Trialurin, Trimyristin, triolein) were cooled at 5 °C/min from the melt at 60 °C down to temperatures between 12 °C and 16 °C, and left to crystallize under a shear rates between 50 and 600s-1 in the Couette cell of a rheometer combined with a NMR spectrometer. SFC values were calculated using the direct method (FID curves). Apparent viscosity and total mechanical energy delivered to the system were precisely measured by the rheometer. Variations in the liquid NMR signal, combined with density measurements, were used to estimate the temperature changes due to the applied shear in the samples. To complement the study, microscope pictures were taken during the crystallization processing under shear to observe the growth of the lipid crystal particles. The observed measurements deviated from common equations (E.g. Krieger-Dougherty) used to describe the dependency of viscosity on solid volume fraction, likely due to the orientation of the crystallites at the higher shear rates.

The Effect of Change in Composition and Processing of Crystallized Fat Products on Product Quality. P. Gerstenberg Kirkeby, Gerstenberg Schröder A/S, Copenhagen, Denmark

Crystallised fat products cover a large number of various consumer spreads and industrial products. It can be stated that the composition of the fat blend determines the application of the final product as the composition will result in a specific solid fat content (SFC) profile which is used to characterise the product. However, the SFC profile is not the only factor to determine the suitability of the fat blend since processing parameters have a great influence on the final product quality such as stability, spreadability and texture. By determining the SFC profile of various blends and comparing this to Differential Scanning Calorimetry (DSC) diagrams, detailed information on the blends is then achieved. In this paper a number of fat blends for spreads will be characterised according to SFC and DSC, and various processing parameters will be applied in order to determine the effect on product quality.

Chocolate Crystallization in the Cooling Tunnel - What Causes Demolding?. K.W. Smith[1], G. Talbot[2], L. Favre[3], [1]Unilever Research Colworth, Sharnbrook, Bedford, UK, [2]The Fat Consultant, Bedford, UK, [3]Loders Croklaan, Wormerveer, The Netherlands

Once tempered and molded, chocolate is cooled, where it crystallizes into the stable β-V form and contracts in the mold leaving it glossy and firm. NMR (SFC) has been used to monitor crystallization in a cooling tunnel, whilst also measuring the hardness and the degree of contraction/demolding. After tempering, there was of the order of 2-3% solid, whether the fat was pure cocoa butter or part CBE. SFC rose rapidly during crystallization, for both cocoa butter alone and part CBE. In both cases, major changes in hardness and contraction occurred after the main crystallization. Thus SFC was at its plateau value several minutes before full hardness and contraction from the mold was achieved. Both contraction from the mold and hardness depend greatly on the extent of the sintering between the fat crystals. Thus, it is the relatively small amount of solid fat formed at the end of crystallization that gives rise to the hardness and contraction. Contraction of fat-based foods is important in several areas including molded products – where it can be important to demold cleanly – and enrobed products, particularly ice-cream, where the coating should remain intact. Further work in the area of crystallization is required to fully understand the process of sintering and network formation, not just nucleation and crystal growth.

The Use of Shear Flow to Nano- and Micro-Structure Crystallizing Lipid Systems. G. Mazzanti, Dalhousie University, Halifax, NS, Canada

In recent years a large amount of research has been devoted to learn how shear flow affects the crystallization of multicomponent lipid systems. The physical properties of these materials depend on the combination of their nanostructure and their microstructure. The documentation of shear induced phase transitions, and the reduction of onset times established an initial body of knowledge on the nanostructural effects of shear flow. Detailed rheological observations and combined methods are now reaching deeper into our understanding of the effects that shear has on microstructure and on thermal properties of lipid materials. The development has now reached the state where improvement of manufacturing practices and introduction of new processes are being undertaken. These advances provide industry with a better ability to understand and predict the behaviour of formulations under previously unexplored crystallization conditions. The tailoring of physical properties of shortenings and other materials is thus expected to benefit from these new opportunities. There are still several challenges to extend fundamental physical chemistry models to shearing conditions. Recent advances in the combined role of x-ray diffraction, nuclear magnetic resonance, rheology and modelling will be discussed as a conclusion to this talk.

WEDNESDAY

MORNING
EAT 4.1: General Edible Applications Technology
Chair(s): G. List, USDA ARS NCAUR, USA; and B. Farhang, University of Guelph, Canada

Factors Governing the Microstructure of Complex Food Systems. K. Dewettinck, Ghent University, Gent, Belgium

Designing foods on a micro- and even a nanoscale is the answer to the consumersâ?? demand for new products that are tasty, satisfying, healthful, convenient, and inexpensive.Moreover it may create added value to by-products and contribute to overall socio-economic welfare.In this presentation, an overview will be given of the different factors that contribute to the microstructural build-up of foods and both compositional and processing parameters will be discussed

Effect of Spray Nozzle Design on Fish Oil Microencapsulation Efficiency. J. Legako, N. Dunford, Oklahoma State University, Stillwater, OK USA

Although fish oil (FO) is recognized for its health benefits FO is easily oxidized. Microencapsulation improves

oxidative stability. Spray and freeze drying are widely used to produce microcapsules (MC). 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 is to examine the effect of nozzle type and design on FO encapsulation efficiency. Three nozzle types, a pressure nozzle with one liquid channel, a pressure nozzle with two liquid channels and a sonic atomizing two liquid channels nozzle were examined. Whey protein and a maltodextrin-casein mixture were used as wall materials. Emulsions were prepared for drying by one liquid channel nozzle and freeze drying. For two liquid channel nozzles, FO and wall material were pumped into the nozzle separately and mixed at the point of atomization. Particle size, particle morphology by scanning electron microscopy and oil content was determined. Surface oil was measured by means of Fourier transform infrared spectroscopy attenuated total reflectance. Oxidative stability was measured by gas chromatography using head space solid phase microextraction to measure volatile oxidative compounds over a period of 15 weeks. Nozzle type and design had a significant effect on physical properties of FO MC.

Cereal Protein Nanoparticles as Controlled Release Vehicles. Lingyun Chen, Zhigang Tian, Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, Alberta, Canada

Barley is ranked fourth of total world cereal production and second major crop in Canada. However, most of barley is used as livestock feed. Current research on value-added applications of barley mainly focuses on barley carbohydrate and oil components. Barley proteins are lack of research effort. Due to their hydrophobic characteristic and good barrier properties at medium relative humidity, barley protein may be a good candidate as biomaterials. In this work, barley protein nanoparticles well dispersed in aqueous solution were successfully prepared. By optimization of the preparation conditions, particle size can be decreased to 150-200 nm with zeta potential of about 28 mV. These nanoparticles demonstrated spherical shape and narrow size distribution observed by TEM. These nanoparticles have potential to be used as controlled delivery systems in food and pharmaceutical applications.

Fry Applications Using a New Mid Oleic, Low Saturate Low Linolenic Soybean Oil. R. Wilkes, L. Jurado, Monsanto Company, St. Louis, MO USA

With the mandatory labeling of trans fats in 2006 and subsequent bans enacted for the foodservice industry, a wide range of trans fat replacements are being utilized in the food industry. Many of these oils however do not provide the needed fry life or flavor quality that is optimum. The agriculture industry continues to develop sustainable trait modified seeds that offer improvement over current solutions. One example is a trait modified soybean oil in which oleic acid has been increased from 24% to 75%, linoleic acid reduced from 52% to 15% and linolenic acid reduced from 7% to under 3%. In addition, total saturated fat content has been reduced from about 15% to 9%. Oil from these seeds has been produced using standard soybean oil processing. Fry studies have been completed utilizing both French fries and chicken that demonstrate improved fry life over other trans free oil options with acceptable flavor quality. Foods fried in this oil maintained virtually trans free with reduced saturated fat levels. Once commercialized, this new trait modified soybean oil will offer an improved trans free option for foodservice and food manufacturers.

Use of High Stearic High Oleic Sunflower Oil in Frying. Eduardo P. Dubinsky[1], Lucas Pan[2], Rafael Garces[3], Joaquin Salas[3], Daniel Peter[4], Monti Cristina[4], Trinchero Jorge [4], [1]Eduardo Dubinsky & Associates, Technical Consultants, Buenos Aires, Argentina , [2]Advanta Semillas, Mar del Plata, Argentina, [3]Consejo Superior de Investigaciones Cientificas (CSIC), Sevilla, Spain, [4]Inta Balcarce, Argentina

Stearic acid is the unique fatty acid that can yield healthy solid fats. By means of fractionation by crystallization of High stearic High oleic sunflower oil (HSHO) different products with different melting profiles could be obtained, tailored for almost every food application. In a previous presentation data characterization of HSHO stearins was shown. Nutrisun olein has very similar characteristics with whole HSHO. The presentation shows the explanation of this behaviour and why the frying performance of the olein is expected to follow a similar pattern than that of the oil.Consequently, the use of HSHO sunflower oil in frying is shown. The main criteria for evaluating frying oils performance are reviewed. Data on frying performance of HSHO sunflower oil in comparison with high oleic sunflower oil and palm olein will be presented. The advantages of the stearic content regarding melting profile (DSC and SFC methods), allow to avoid clumping of the fries in industrial frozen par frying.This means the possibility of

having healthier frying products for replacing those obtained using conventional shortenings (partially hydrogenated) with high content of trans fats and also those rich in "bad" saturates different from stearic, which increase the cholesterol and the risk of CVD.

Global Edible Oil Industry at Crossroads: The Way Forward. Rajan Skhariya, Mecpro, India

TITLE : GLOBAL EDIBLE OIL INDUSTRY AT CROSSROADS: THE WAY FORWARDAUTHOR : RAJAN SKHARIYAINSTITUTION: MECPRO HEAVY ENGINEERING LIMITED, NEW DELHI, INDIAABSTRACTWe are gathered here to reflect rationally and recommend steps to steer out the Edible oil Industry, by making careful decisions.Mecpro, has been able to develop two very innovative technologies, namely, Zero Effluent Refining & Hot Spray Extraction for enhanced Extraction.With Zero Effluent Technology, the phosphorous content can be reduced below 5 PPM in the oils, without discharging any effluents.In this process, the oil losses and energy consumption, can be reduced substantially. In addition to above, oil quality would be improved, as there would is be no cloudy oil recovery from gums.The extraction rate is dependent on the time and temperature during the process and world over the oil extraction is done with hexane temperature ranging between 55-60oC. However, in our Hot Spray Extraction technology, extraction is done by rising temperature of Hexane to 90oC, for faster and better extraction.Under this hot oil extraction process, cakes of Mustard/Groundnut etc. which carry over 1.5% to 1.8% oil with them is reduced to the level of between 0.6% to 0.7%, thus enhancing extractability.

Formulation of Zero *trans* Liquid Oils, Vegetable Ghee, Margarine, Shortening, and Puff Pastry Shortening and Margarine. Firouz Madadnoee[1,2], Mohammadreza Modalal[1,2], Farshad Karami[1], [1]Agri-Industry & Veg. Oil of Mahidasht, Kermanshah (A.I.V.O.M. Co.), Iran, [2]Kesht Va Sanat Shomal(KVSS), Mazandaran, Iran

We have successfully reduced *trans* fatty acid in all our formulations to zero. In liquid oils we reduced 18:2 and 18:3 *trans* fatty acids (TFA) from canola and soybean oil by adjusting deodorizing time and temperature. Vegetable ghee is traditionally preferred for household use in Iran, Middle Eastern and some East Asian countries therefore there is still a huge market for this type of product. By blending different types of oils we formulated vegetable ghee with melting point of 37-38 , TFA less than 1% and saturated fatty acids(SFA) less than 30%. We have also formulated two types of margarines with less than 1% TFA, table margarine with less than 42% SFA and industrial margarine with less than 45% SFA. We have formulated several types of shortening for various applications with less than 1% TFA and with 37% SFA for cookies, muffins, cake and etc. and with 55% SFA for biscuit filling. We gradually reduced TFA from these types of products. We have formulated pastry shortening and margarine with less than 1% TFA and 50% SFA and similar application of high *trans* pastry shortening and margarine by blending of different types of palm oil fractions, liquid oils and 1% emulsifier.

Total Antioxidant Capacity of Vegetable Oils is Determined by α, β and γ Tocopherols and not by δ-Tocopherol. V.N. Castelo-Branco, A.G. Torres, Laboratorio de Bioquimica Nutricional e de Alimentos, Departamento de Bioquimica, Instituto de Quimica, Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brazil

Total antioxidant capacity (TAC) of vegetable oils (VO) can be influenced by tocopherols (T), tocotrienols (T3), fatty acids (FA) and their interactions. However, the determinants for TAC in VO are not yet known. The aims of this study were to determine the TAC of VO and to investigate its dependence on T, T3 and FA levels. Three brands of each of soybean (SO), sunflower (SUN), corn (CO) and canola (CA) oils were analyzed. The contents of T and T3 (α, β, γ, and δ) were determined by normal-phase HPLC, and those of FA were determined by GC-FID. The TAC was determined by the trolox equivalent antioxidant capacity assay (TEAC) in whole oil, and lipophilic (LF) and methanolic (MF) fractions. Multiple Regressions were used to investigate the chemical determinants of TAC in the whole oil and the LF. Composition of FA, T and T3 in the VO were similar to published data. The LF contributed with most of TAC of whole oil samples. The best multiple linear regression models for TAC of whole VO and LF were, respectively: γ-T and β as independent variables (R^2= 0.98; P< 0.0001);α e γ-T as independent variables (r^2= 0,97; P< 0.0001). Therefore, the γ-T was the main chemical determinant of TAC of whole VO and the LF, and other important determinants were α, and β-T indicating the importance of specific components of oils to TAC

Next Generation Solutions for Replacing *trans* Fats. S. Knowlton, DuPont Company, Wilmington, DE, USA

Food package labeling requirements which commenced in 2006 have been highly effective in bringing about a dramatic change in the food industry away from fats containing trans fatty acids. Trend estimates show that there has been a shift in use away from partially hydrogenated soybean oil into alternatives including palm, canola, and corn oil among others. Some segments of the food industry have experienced more difficulty replacing trans containing fats than other segments. In particular, the baking and certain portions of the frying industry continue to search for long term solutions that are both economically viable and environmentally sustainable.A number of new oils including those with modified traits are on the horizon and will be commercially launched in the next few years. Among those will be high oleic soybean oil which is expected to have a limited commercial release* in 2009. This oil has about 80% oleic acid and less than 3% linolenic acid making it an ideal and flexible profile to fit a number of high stability applications. In addition, as an excellent source of monounsaturated fatty acids coupled with reduced saturates compared to commodity soybean oil, the product provides a more healthful alternative to some of the trans solutions currently being used by the industry. *pending regulatory approval

Non-TAG Oil Structuring, New Insides for Oryzanol and Sitosterol Systems. A. Bot, E. Floter, Unilever R&D Vlaardingen, Vlaardingen, The Netherlands

Low molecular weight structuring agents that can serve as an alternative to crystallising triglycerides in edible oils have raised considerable interest in recent years. The requirement that potential structurants should at least hold the promise to be allowed in food applications is a severe limitation. Nevertheless, several systems have been identified, amongst which the class of Î³-oryzanol + sterol organogelators. Mixtures of Î³-oryzanol and Î²-sitosterol are able to form transparent organogels in edible oils. Small-angle x-ray scattering was used to elucidate the microstructure of the building blocks of these organogels in sunflower oil. It was found that the plant sterol(ester)s form hollow tubules with a diameter of 7.2Â±0.1 nm. Tubules prepared with Î³-oryzanol-rich structurant show the least bundle formation, and can be supercooled during formation most easily. The tubules vanish at the melting point of the gel, in agreement with the loss of structuring capacity as observed in earlier experiments. Moreover, a number of alternative sterols (e.g. stigmasterol, cholesterol, cholestanol) can replace Î²-sitosterol in the tubules. The tubule diameter for these systems varies between 7.2 and 8.0 nm, the wall thickness between 0.6 and 1.1 nm.

EAT 4: Guided Crystallization / Solidifications
Chair(s): N. Garti, Hebrew University of Jerusalem, Israel; and N. Widlak, Archer Daniels Midland Co., USA

Crystallization Behavior of *trans*-Fat Alternative Fats Made by Interesterification of Fully-Hydrogenated Vegetable Fat and Vegetable Oil. K. Sato, H. Muramoto, S . Ueno, Graduate School of Biosphere Sciences, Hiroshima University, Higashi-Hiroshima, Japan

We have observed the crystallization behavior of various fats made of interesterified fats of fully-hydrogenated soybean oil and soybean oil by using optical microscope, X-ray diffraction and DSC. Three fats were examined: interesterified fat made of fully-hydrogenated vegetable fat and vegetable oil (Fat A), low-melting fraction of Fat A obtained by dry fractionation (Fat B), and the mixture of Fat B and vegetable oil. The major high-melting triacylglycerols were SSS, SOS and SSO in Fat A, and SOS and SSO in Fat B. In the three types of fats, we observed a common feature that the stable beta-form was easily crystallized instead of beta-prime form. This was due to the formation of beta-form of molecular compound crystals made of SOS and SSO, which strongly favors the formation of beta-form with double-chain length structure. This study indicates the difficulty in preparing trans-fat alternative hard fats for margarine and shortening through the interesterifcation of fully-hydrogenated vegetable fat and vegetable oil.

Exploring the Relationships between Solid Fat Content, Rate of Crystallization, Differential Scanning Calorimetry and Changes in Triaclyglycerol Structure. Neil Widlak, Mark Whitehead, Dawn Sikorski, Bryan Kickle, Archer Daniels Midland Co., USA

Replacing partially hydrogenated shortenings with palm based shortenings and interesterified based shortenings has met a few challenges for product developers. Some palm based and interesterified based shortenings (interesterified blends of fully hydrogenated fats and vegetable oils) while formulated to achieve the same solid fat content as the

partially hydrogenated do not provide the same melting and textural characteristics, and therefore, do not provide the same functinal properties of the partially hydrogenated shortening they are designed to replace. Both palm based shortening and some interesterified based shortenings exibit a characteristic of post hardening, which is not characteristic of most partially hydrogenated shortenings, using standard chilling processes utilized for making commercial shortenings. This paper provides a summary of some of our work to help define the differences between partially hydrogenated, palm and interesterified shortenings by understanding the relationships between solid fat content, rate of crystallization, differential scanning calorimetry and triaclyglycerol profiles.

Are Van Der Waals Interactions Responsible for the Mechanical Strength of Fats?. M. Fernanda Peyronel, Alejandro G. Marangoni, University of Guelph, Guelph, Ontario, Canada

It is widely known that fats have an underlying crystal network composed of polycrystalline particles aggregated into larger agglomerates. It has been accepted for many years that the van der Waals force is the one responsible for the stabilization of this crystal network. The objective of this work is to calculate and compare the Hamaker constant via different methods for samples of Fully Hydrogenated Canola oil mixed with High Oleic Sunflower Oil. The first method uses the Lifshitz approximation for which the index of refraction and the relative permittivity were measured. The second method uses the mathematical expression developed by our group, which relates the shear elastic modulus with the fraction solid. A third method, the semi-classical approach is also explored. Values in the range of 10^{-21} J to 10^{-22} J were obtained for both, the first and second method, while the third method showed values in the range of 10^{-20} J. These results help understand that van der Waals interactions are, in fact, responsible for the mechanical strength of fat crystal networks.

Is a Liquid Structure Developed Before Triglyceride Crystallization? Some Evidence by Anisotropy and Rheology Measurements. E. Dibildox-Alvarado[1], A. Marangoni[2], J. F. Toro-Vazquez[1], [1]Universidad Autonoma de San Luis Potosi, San Luis Potosi, SLP, Mexico, [2]University of Guelph, Guelph, Ontario, Canada

The anisotropy (*r*), rotational viscosity(η), and loss modulus (G") during cooling and isothermal conditions was measured in mixtures of 25% tripalmitin (TP) or tristearin (TS) in triolein (OOO), safflower oil high in triolein (66%, SFO), or soybean oil (SBO). The *r* was measured by fluorescence polarization spectroscopy. Initially, the mixtures were cooled (10°C/min) from 80°C until attaining a given crystallization temperature (T_{Cr}, 36°C-41°C for the TP system and 46°C-51°C for the TS system) determining the induction time for crystallization (T_i) by diffraction light scattering. In parallel experiments *r*, η, and G" were measured during the cooling stage and under isothermal conditions until achieving T_i. During the cooling stage the *r* and η of the systems increased exponentially as a direct function of supercooling while G" = 0. However, once T_{Cr} was achieved and before the T_i all systems showed measurable G" values and *r* increased esponentially as supercooling increased. These results showed that a liquid structure was developed during the isothermal stage before nucleation. The DSC results showed that when TP or TS crystallized directly from the melt in the β polymorph, the increase of *r* as function of supercooling was not followed.

Omega-3 Enrichment and *trans* Fatty Acid Reduction in Bakery Products. E.M. Kim, R. Damázio da Silva, Y. K. Chang, D. Barrera-Arellano, C.J. Steel, University of Campinas - UNICAMP, Campinas, São Paulo, Brazil

Bakery products are widely consumed and can be used as carriers for functional ingredients. On the other hand, due to the high fat content of some bakery products, problems related to health, such as those attributed to trans fatty acids, have a certain impact. This work shows the results of two studies: the first, involving the effects of processing on the retention of omega-3 fatty acids added to pan bread, observing the negative effects of temperature and possible positive (protective) effects of carbon dioxide produced by the yeast, and the second, evaluating the effects of different fats (palm oil, hydrogenated and interesterified vegetable fats and soybean oil) on the technological quality of bakery products with higher quantities of fat in their composition (pan bread and pound cake). The Response Surface Methodology was used and significant effects were found for omega-3 on specific volume, strange taste intensity and omega-3 retention. In the second study, it was observed that the different fats behaved differently in the different bakery products. Whilst in pan bread palm oil produced loaves with greater specific volume and soybean oil produced less firm loaves during all the storage period, in cakes, soybean oil had the opposite effect, increasing batter density,

reducing cake specific volume and increasing firmness during all the storage period.

Templated Co-crystallization of Cholesterol and Phytosterols from Microemulsions. N. Garti, S. Rozner, I. Popov, V. Uvarov, A. Aserin, The Hebrew University of Jerusalem, Jerusalem, Israel

High cholesterol (CH) in the blood can cause cardiovascular diseases. One of the solutions to high CH values is the intake of phytosterols (PS) known as CH-reducing agents.One of the proposed mechanisms for the PS activity is the mutual co-crystallization of CH and PS in the dietary mixed micelles (DMM) resulting in a removal of excess CH from the transporting micelles. In this study, microemulsions (ME) were used as a model system for the co-crystallization mimicking Diatery Mixed Micelles (DMM) and/or as possible pathway to reduce solubilized CH.The effects of: (1) different CH/PS ratios; (2) effect of dilution; (3) effect of lecithin-based MEs on sterols crystallization, were studied.We learned that the precipitated crystals from ME-loaded system with PS alone and from those loaded with 1:1 CH/PS mixture were significantly influenced by the ME micro structure and by the dilution with aqueous phase (XRD and DSC results). No new polymorphic structures were detected apart from the corresponding sterol hydrates.The mixed crystals morphology and habit was strongly affected by the CH/PS ratio and the structures of the diluted-ME. As the amount of PS in the mixture increased, or as the dilution proceeded, the precipitated crystals turned to be more needle-like in their shape.

Effect of *trans* Fat Content on Rheology of Dough and Texture of Cookie. Behic Mert[1], Aziz Tekin[2], Kubra Sahin[2], Hakan Erinc[2], [1]Food Engineering Department Middle East Technical University, Ankara, Turkey, [2]Food Engineering Department, Ankara University, Ankara, Turkey

In this study the effects of *trans* fatty acids on dough rheology and cookie texture were systematically studied. Firstly, *trans* rich fat stocks were produced in our laboratory using a selective catalyst (Nysosel 810, BASF) in hydrogenation. Then three different groups of fat blends having similar solid fat content (SFC) but different *trans* fat content were prepared. In total 18 different fat blends were produced and they were separated into three groups in terms of SFC values. *Trans* fat content varied from 0% to 56% in the first group, from 0% to 48% in the second group and from 0% to 35% in the third group. In the next step, dough samples were prepared using these blends and the dough samples were analyzed in terms of rheological properties. Although the fat blends had similar SFC values, measurements showed that the trans fat content of the fats had significant effects on linear viscoelastic properties. Furthermore, texture measurements showed that dough samples prepared using low *trans* fat blends had significantly smaller elongational viscosity. In the next part, wire cut type cookies were prepared using the prepared fat blends and texture measurements were conducted. Measurements indicated that increasing *trans* fat content resulted in cookies with smaller fracture stress and Young?s modulus values.

AFTERNOON
EAT 5: Structured Lipid-based Fluids
Chair(s): D.K. Nakhasi, Bunge Oils Inc., USA; and F. Orthoefer, FTO Consulting, USA

Development of New Lipid Products and Their Production through Lipase Technology. T.K. Yang, Dalian University of Technology, Dalian, Liaoning, China

Lipase technology/new lipid products: production of structured lipids, human milk fat substitutes and food emulsifiers by lipase technology.Healthful edible fats with new structure: beneficial function of less accumulation in body, and production methods.Oxidation and natural antioxidants: mechanism of oxidation and antioxidation, and criteria for natural antioxidants.Fat refining/new technology: processing of oils and fats by membrane technology.Biofuels/oils & fats: biodiesel from byproduct of fat processing, and natural tocopherols and phytosterols also produced from the process.

Formulation of Healthier Fat-based Products. J. Neddersen[1], T. Elliott[1], P. Wassell[2], [1]Danisco USA, New Century, KS, USA, [2]Danisco A/S, Brabrand, Denmark

Today, consumers are trying to incorporate healthier products into their diets whenever possible. Typically, fat-based products aren′t perceived as a product category that lends itself to health and wellness. This presentation will focus on the formulation of several healthier fat-based products including a low fat puff pastry margarine, a low fat spread considered a good source of fiber and other healthier fat-based concepts.

Development of Omega-3 Enriched Foods Utilizing Stearidonic Acid. R. Wilkes, Monsanto Company, St. Louis, MO USA

Launch of omega-3 enriched foods has not yet met its potential. When formulating foods from marine sources initial flavor quality and shelf life can be compromised. Work continues developing sustainable crop based sources of omega-3 with declining fish supply concerns. Soybeans have been enriched with stearidonic acid (SDA), the intermediate omega-3 fatty acid in the conversion of alpha linolenic acid (ALA) to eicosapentaenoic acid (EPA). SDA is more readily converted to EPA than ALA. Clinical studies have demonstrated enrichment of EPA in red blood cells when SDA is part of the diet. Oil is processed similar to conventional soybean oil, is bland in flavor and successfully added to a range of foods resulting in acceptable flavor and shelf life. Fruit and nut granola bars were developed incorporating SDA and other omega-3 oils and evaluated throughout the 12 month shelf life. Bars made with SDA were similar in flavor and off flavor to control bars throughout the 12 month shelf life. There was equal consumer acceptance for overall liking and flavor liking between the SDA enriched and control prototypes. Bars made with other omega-3 oils exhibited increased off flavor notes and shortened shelf life. The results demonstrate that SDA enriched soybean oil can be formulated into long shelf life, shelf stable products without flavor and shelf life compromise

Performance of Structured Lipids Incorporating Selected Phenolic Acids. E. Gruczynska, R. Przybylski, University of Lethbridge, Department of Chemistry & Biochemistry, Lethbridge, Alberta, Canada

Synthetic antioxidants may have negative health effects and as consequence it is a great interest in natural antioxidants such as ascorbic acid and other phenolic components. However, the hydrophilic property of these compounds reduces their application in fats and oils. Therefore, the incorporation of phenolic compounds into triacylglycerol is offering structured lipids soluble in oil. The main goal of this study is implementation of selected phenolic components directly into TAG's of canola oil. Applying enzymatic transesterification we were able efficiently produce novel structured lipids containing nutraceuticals and antioxidants. We found that substrates molar ratio, reaction time and type of organic solvent were the main factors affecting yield and the type of structured TAGs produced. Oxidative stability of the novel structured lipids, assessed by Schaal Oven test, showed significant improvement in resistance to oxidative degradation compared to original canola oil. Developed structured lipids containing nutraceuticals and antioxidants may directly affect nutritional properties of lipids for human consumption also offering nutraceutical ingredients for food formulation.

Enzymatic Interesterification of Palm Oil and Fractions. V. Gibon[1], R. Costales-Rodriguez[1], G. Calliauw[1], N. De Clercq[2], S. Danthine[3], K. Dewettinck[2], W. De Greyt[1], [1]Desmet Ballestra Group, Zaventem, Belgium, [2]Ghent University, Ghent, Belgium, [3]Gembloux University, Gembloux. Belgium

Enzymatic interesterification received considerable attention in recent years as an alternative to chemical interesterification for margarine and shortening formulation. It is also more and more applied for the preparation of tailor-made lipids aiming at specific applications (CBE, human milk fat substitutes, etc). In this work, interesterification of palm oil and selected fractions was investigated chemically and enzymatically. Palm Oil, Palm Olein and Soft PMF are characterized by variable PPP and POP contents. POP is similar in Palm Oil and Palm Olein while it is substantially increased in Soft PMF; both Palm Olein and Soft PMF are seriously depleted of PPP. Whatever the matrix, the strongest compositional modifications were attributed to PPP and POP. The degree of interesterification was evaluated using two methods: one based on triacylglycerol composition (by HPLC) and the other on solid fat content profile (by p-NMR). Reaction rates were derived and mechanistic considerations were developed in relation with the variable POP/PPP ratios in the starting fats. For Palm Oil, DSC was used to follow the degree of interesterification; crystallization properties were investigated and compared to the native fat. Interesterified palm oil was dry fractionated and quality of the produced fractions was evaluated in terms of compositional, thermal

and crystallization properties.

Products Formed during Thermo-oxidative Degradation of Sitosterol. M. Rudzinska[2], R. Przybylski[1], E. Wasowicz[2], [1]University of Lethbridge, Department of Chemistry & Biochemistry, Lethbridge, Canada , [2]Institute of Food Technology of Plant Origin, Poznan University of Life Sciences, Poznan, Poland

Phytosterols, like in chemical structure to cholesterol, undergo the same oxidative degradation and the presence of oxidized derivatives has been found in many foods and feed products. In this work the main goal was establishing what components are formed during oxidative degradation of phytosterol in addition to oxidative derivatives. Sitosterol standard which contained sitostanol, campesterol and campestanol were thermally treated at temperatures simulating food processing for different periods of time. During thermo-oxidative degradation the following groups of components were formed: oxidized sterols, volatile components, partially decomposed sterol molecules and oligomers. Type and the amount of different components was affected by the temperature and time applied. The total amount of intact sterols decreased when temperature and time increased. We established that oxidized derivatives of sterols are primary products which further decompose to generate volatiles and partial sterol molecules. Identified volatile components belong mainly to the same group of off-flavor compounds as defined for oils and fats off-flavors. Furthermore primary oxidized products interact among themselves and with other degradation compounds to generate numerous oligomers. For the first time we were able to balance the amount of decomposed sterols with the amount of the degradation products formed and we observed enormous components formed.

Edible Applications Technology Posters

A Recent Indian Innovation in Mustard Seed Processing.
Dwijendra Mathur, Chandra Shekhar Joshi, Meenakshi Tripathi, FARE LABS Pvt. Ltd., Gurgaon, Haryana, India

The cold expeller technology, a recent Indian innovation in mustard seed processing, was developed to overcome the limitations of the traditional Kachchi Ghani process while retaining its key benefit – oil pungency. Ghani is a batch process with small batch sizes of 16 – 18 kg of seeds crushed in 1 – 1.5 hours with a low oil yield of upto 20%. With small batch sizes, oil quality can vary significantly with each batch; other disadvantages include higher requirement for labour, space, power, and crushing time. The process is also environment unfriendly as it uses wooden pits that need to be periodically replaced. Ghani, being a small scale process, has largely been restricted to the unorganised sectors that employ inefficient management systems making Ghani an expensive process.To make the Ghani process more cost effective and quality oriented, studies were carried out on pilot scales. It was seen that cold expellers can produce pungent oil by maintaining temperature and moisture at desirable levels. Such expellers have now been successfully employed at industrial levels. With this technology, power consumption, processing cost, space requirement, and maintenance cost can be reduced by upto 20, 30, 40, and 50% respectively; other benefits include increased oil shelf life, enhanced oil recovery of upto 30%, consistent quality output (being a continuous process), and better hygiene.

Physicochemical Characterization of Fat Blends Related to Margarine Formulation.
S. Danthine[1], J. Fernando Munoz[3], V. Cavillot[1], J. Wouters[4], V. Gibon[2], C. Deroanne[1], [1]FUSAGx, Gembloux, Belgium, [2]DeSmet Ballestra, Zaventem, Belgium, [3]Danec SA, Sangolqui, Quito, Ecuador, [4]FUNDP, Namur, Belgium

The functionality of margarines and shortenings is dependant of several factors and related to the final application of the product. For example, bakery margarines are formulated to a higher solids content than table margarines (spreads) to ensure good baking properties. Also, small β prime crystals are preferred in fats for cakes since they give increased firmness and air incorporation in the batter at a given SFC. Since margarines are characterized as water-in-oil emulsions like butter, their functionality depends to a large extend on the fat blend, and more precisely on its crystallization and melting properties. In this work, we focused on the physical characterization of some fat systems made of palm oil or some of its derived products, especially solid fat content (SFC) by pNMR and melting profile by differential scanning calorimetry (DSC). Polymorphic stability was also evaluated by powder X-ray diffraction. Ternary diagrams were then constructed using those datas. Comparison was made with commercial products. Some

areas of the ternary diagrams (and thus some blend compositions) were comparable to commercial products.

Time-temperature Effects on the Stability of a Monoglyceride-Oil-Water Shortening Alternative.
Carolyn Challacombe, Brittany Huschka, Koushik Seetharaman, Alejandro G. Marangoni, Department of Food Science, University of Guelph, Guelph, Ontario, Canada

The stability of an opened container of a novel monoglyceride-oil-water shortening alternative (MAG gel) containing 4.5% monoacylglycerol, 0.22% stearic acid, canola oil and 30, 35 or 40% water was monitored for a period of 5 weeks at room temperature (22°C) or in cold storage (8°C). The dropping point (DP) of the 40%, 35%, and 30% water-containing samples stored at RT remained constant, while the DP of cold-stored samples decreased by 10, 9 and 12 degrees, respectively, following storage. The peak melting temperature determined by differential scanning calorimetry did not change during storage for any of the samples. Water syneresis was observed only in the cold-stored samples after 3 weeks, and reached 8%, 6.5% and 3% (w/w) for samples containing 40%, 35% and 30% water, respectively. These results are consistent with the notion that H-bonding between MAG hydroxyl groups is strengthened at cold temperatures, causing shrinkage of the inter-lamellar region, resulting in syneresis. This is partially responsible for the destabilization of the MAG multilayers and the observed decrease in DP.

Industrialized Food Products Free of *trans* Fatty Acids can Really be Found in Sao Paulo?.
Tatiane Bottan, Elizabeth Aparecida Ferraz da Silva Torres, Tatiana Saldanha, Faculdade de Saúde Pública-Universidade de São Paulo, São Paulo, São Paulo, Brazil

Trans fatty acids (TFA) has been widely used by the food industry. However, the intake of TFA has been associated with health problems. These lipids on plasma lipoproteins can contribute to increase the risk of cardiovascular diseases. Therefore, many studies have recommended the substitution of this kind of fatty acid for reducing its intake. In Brazil, the National Health Department established that the content of TFA must be informed on the label of the industrialized food products. Apparently, this regulatory measure stimulated the appearance of several ?TFA-free? food products. Due to this, this work intends to quantify the offer of TFA-free industrialized food products through the information available on the label of products sold in six supermarkets of Sao Paulo city. For this, were chosen two of the five food groups that are more acquired by the inhabitants of São Paulo (salted biscuits and sweet biscuits) according to the Brazilian Family Budget Survey (2003). Through those information, will be checked if the offer of TFA-free food products vary in different regions of the city that were separated by terciles of HDI (Human Development Index). Also, will be checked if the content of TFA is correlated with the price of the products. From the results, we will discuss if there are a widely offer of TFA-free foods in Brazil.

Effect of Oleic Acid Addition in the Production of Lipid Microparticles of Stearic Acid by Spray Cooling.
M.D.M.M. Ribeiro, C.R.F. Grosso, D. Barrera-Arellano, University of Campinas - UNICAMP, Campinas, São Paulo, Brazil

The objective of this work was to evaluate the addition of oleic acid in different proportions, as a modifier of the stearic acid crystallization into lipid microparticles produced by the spray cooling process, containing glucose solution as core and lecithin as surfactant. Blends were characterized by the fusion and crystallization curves behavior by thermal analysis (differential scanning calorimetry). Stearic-oleic formulations to obtain a stable emulsion were optimized. Encapsulation efficiency, particle size distribution, morphology and release behavior were evaluated. The lipid microparticles are spherical and wrinkled. The addition of oleic acid, as far as the crystallization of the lipid matrix modification, has contributed to the core incorporation, providing lower surface glucose concentration in the lipid microparticles between 2 % to 7% in the blends and 22% to stearic acid. The release behavior was also modified, being higher for stearic acid when compared to the blends containing oleic acid. The encapsulation efficiency was higher (93% - 97%) in the blends that in the stearic acid microparticles (75%).

Properties and Stability of SolidLipid Particles based on Canola Stearin and Poloxamer 188.
C.C. Trujillo, S. Langmaid, A.J. Wright, University of Guelph, Guelph, ON, Canada

Solid lipid particles (SLP) are one strategy for encapsulating lipophilic molecules, including for controlled release and enhanced bioavailability. SLP based on fully hydrogenated canola stearin (CaSt) and the non-ionic surfactant

Poloxamer 188 (P188) were produced by hot high pressure homogenization using a microfluidizer. Spherical particles in the range of 140 nm were produced under conditions optimized for lipid and surfactant concentration, processing pressure and number of homogenization cycles. The CaSt:P188 ratio was the primary determinant of particle size, provided a minimum energy input was provided. P188 had a significant effect of decreasing particle size and facilitating transitions from the alpha to the beta polymorph ($P<0.05$). Destabilization of the SLP dispersions, sometimes evidenced by sample solidification, was commonly observed at high lipid concentrations (i.e. 20 and 30%) and with the introduction of shear. Solidification was not associated with polymorphic transitions. A stability study of the 10% CaSt SLP containing 0, 1, or 5% P188 at 4 or 20°C revealed particle destabilization for the 0 and 1% systems, especially at 20°C, but no changes in the 5% SLP at either temperature for up to 240 days.

Effects of Chemical Interesterification on Physicochemical Properties of Blends of Palm Stearin and Palm Olein.

Fabiana Andreia Schafer De Martini Soares, Roberta Claro da Silva, Kelly Carolina Guimarães da Silva, Thais Gonzaga Fernandes, Luiz Antonio Gioielli, Universidade de São Paulo, São Paulo, São Paulo, Brazil

The challenge of the food industries in the replacement of trans fat in various products lies in the development of formulations and processes which have equivalent functionality and economic viability. The chemical interesterification of blends of palm stearin and palm olein is important technological option for the production of fats targeting commercial applications. Fat blends, formulated by mixing palm stearin and palm olein in different ratios, were subjected to chemical interesterification. The following determinations, before and after the interesterification reactions, were done: fatty acid composition, softening point, melting point, solid fat content and consistency. For the analytical responses a multiple regression statistical model was applied. Results indicated that interesterification of blends with high content of palm olein caused increase on physicochemical properties. The mixture and interesterification allowed to obtain fats with various degrees of plasticity, increasing the possibilities for the commercial use of palm stearin and palm olein.

Enrichment of Anhydrous Milk Fat in Polyunsatured Fatty Acid Residues from Linseed and Rapeseed Oils through Enzymatic Interesterification.

M. Aguedo, S. Danthine, E. Hanon, M. Paquot, G. Lognay, A. Thomas, M. Vandenbol, P. Thonart, J-P Wathelet, C. Blecker, FUSAGX, Gembloux, Belgium

Lipozyme TLIM was used in a solvent-free batch, microaqueous system for enzymatic interesterification of anhydrous milkfat (AMF) with linseed oil (LO) in binary blends and with rapeseed oil (RO) in a ternary blend. Binary blends of AMF/LO 100/0, 90/10, 80/20, 70/30, and 60/40 (w/w) were interesterified.The changes in triacylglycerol (TAG) profiles showed that quasi-equilibrium was reached after 4–6 h of reaction. The decrease in SFC and in dropping point temperature obtained with increasing content of LO and interesterification resulted in good plastic properties for the products originating from the binary blends 70/30 and 60/40. This was confirmed by textural measurements. DSC showed the complete disappearance of low-melting TAG from LO and the formation of intermediary species upon interesterification. Rancimat oxidative stability index (OSI) was inversely correlated with LO content. A ternary blend composed of AMF/RO/LO 70/20/10 gave satisfactory rheological properties, and enhanced OSI compared to binary blends. A complementary study concerning shelf-life and oven-ageing of interesterified products was also undergone. Results are presented separately in : Interesterification of anhydrous milk fat with rapeseed and/or linseed oil:oxidative stability.

Comparison of the Theoretical and Experimental Composition of Crystallizing Lipid Mixtures.

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To predict crystallization behaviour of lipid mixtures, it is essential to understand their equilibrium phase composition. The non-isothermal crystallization and polymorphism of binary mixtures of trilaurin and trimyristin was investigated using DSC, small and wide angle synchrotron radiation x ray diffraction. DSC was used to identify the temperatures at which phase changes occurred. The α-phase was present only at cooling rates > 5 C/min for compositions > 20% trimyristin, whereas the β' phase was always present. Theoretical onset compositions were estimated using the model

by Los et al., for different kinetic constants ratio and excess free energy parameters. To estimate the experimental composition from the x-ray data, we propose a mathematical relationship between the solid mole fractions and the d-spacing, together with a weighing function expressed in terms of the solid fractions. The model takes into account the existence of more than one α and β' phase at the end of cooling. Model functions used included linear, parabolic and cubic functions of the composition to the d-spacings and intensities. The composition was best estimated as a product of quadratic function of the d-spacings and intensity with a correction factor. The model parameters were however strongly intercorrelated.

Insights into the Effects of Shear Flow on the Mechanical and Thermal Properties of Cocoa Butter.

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Cocoa butter was crystallized under different shear rates from 50°C at three cooling rates (0.5, 1 and 2°C/min) to three end temperatures (16, 18 and 20°C). Sheared samples were examined with DSC on days 0, 1, 7 and 28. Six of the nine temperature sets showed a critical shear rate, above which the melting points were dramatically different than for low shear and no shear samples. For the day 0 and day 1 samples, above 500 s-1 the melting temperatures were ~2°C higher than for 360 s-1 and below. For days 7 and 28, above 500 s-1 the peak melting temperatures were ~2°C lower than for the lower shear and no shear samples. Orientation was present in all temperature sets for shear rates of 360 s-1 and higher. Breaking stress measurements on sheared and non-sheared samples showed results remarkably similar to those seen in the DSC tests, with a critical shear rate existing in six temperature sets, above which an increase in the breaking strength occurs. Samples on either side of the critical shear rate yielded two distinct x-ray patterns leading to speculation that the application of high shear rates causes the formation of a compositionally different form V crystal with fewer defects than its lower/no shear counterparts.

Non-Isothermal Crystallization of Binary Mixtures: Use of Thermal Methods to Estimate Final Compositions.

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Fats are mainly mixtures of triglycerides (TAGs) which can crystallize with several phases coexisting. Non-destructive compositional analyses are necessary to understand the physical chemistry of the mixtures. Different polymorphic and compositional phases have different molar heat capacity and enthalpy values. The α form, for instance, has the highest heat capacity and least enthalpy value. Pure α and α-rich phases are formed at relatively fast cooling rates. In lipid binary systems, crystalline phases have different mixtures of compositions and polymorphs, which makes the identification process a big challenge. To develop this method, we studied a binary system (Trilaurin-Trimyristin) crystallized at different cooling rates or final temperatures. The proportions of the compositions of the crystalline phases present were estimated combining the corresponding enthalpy and heat capacity values with the mass balances of the systems, and compared to x-ray diffraction estimates. These values were obtained by using Differential Scanning Calorimetry DSC, Modulated Differential Scanning Calorimetry MDSC®, and Thermal Relaxation (in a Physical Properties Measuring System PPMS).

Crystallization of Tripalmitin during the Development of Candelilla Wax Organogels.

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The crystallization and melting properties of the solid phase developed by mixtures of tripalmitin (TP, 0, 0.5, and 1.0%) and candelilla wax (CW, 0 to 3.0%) in safflower oil (SFO) were evaluated by DSC, microscopy, and rheometry. The objective was to investigate how the thermal and the rheological properties of the CW organogel was affected by the crystallization of TP. Results showed that without CW, the crystallization of TP at the concentrations and temperatures (T_{set} , -10°C to 25°C) investigated did not develop a crystal network that provided solid like behavior to the SFO. The melting temperature (T_{set}) of CW organogels developed without TP increased from ≈30.5°C up to ≈42.5°C as a function of CW concentration. However, the thermograms of the CW_TP systems showed that TP crystallized at higher temperature than without CW. Additionally, in the CW_TP organogels the T_m remained between

36°C and 38°C, independent of the CW concentration and T_{set}. In contrast the heat of fusion was function of TP and CW concentration. Overall, the CW_TP organogels had higher G′ and yield stress than CW organogels, particularly at T_{set} of -5°C and 15°C. The molecular interaction between TP and CW components during the crystallization/gelling process resulted in organogels with physical properties of potential use in food systems.

The Effect of Lipids on Recognition Thresholds of the Five Basic Tastes.
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In addition to the contribution of lipids to food texture and aroma, the effect of lipids on taste perception is now commonly studied. Findings suggest that lipids may affect taste perception through lipid composition (i.e. high concentrations of polyunsaturated fatty acids). This study assessed the effect of lipid composition on the recognition thresholds of the basic tastes (i.e. sour, umami, bitter, salty, sweet) in emulsion model systems. Thresholds in aqueous systems were determined for comparison. Emulsions were 20:80 oil-in-water emulsions containing either anhydrous milk fat (AMF), soybean oil (SBO), or a 1:1 ratio of milk fat and soybean oil (AMF/SBO) as the lipid phase. Thresholds were determined according to the ASTM forced-choice ascending concentration series method .As expected, aqueous thresholds were generally much lower than those of respective emulsions. Exceptions were the sweet AMF-containing and umami AMF/SBO-containing emulsions which had the same thresholds as their corresponding aqueous solutions. Though lipid composition affected emulsion thresholds for all tastes except bitter, a relationship between thresholds and lipid composition was not established. These results suggest that the role of lipids in taste perception is more complex than simply correlating with an increase in polyunsaturated fatty acids.

Surfactant Microemulsion Based Oil Extraction from Corn Germ.
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Commercial corn oil is typically obtained by mechanical pressing of the corn germ and/or extracting the germ with hexane. Because of the adverse health effects of hexane, alternative solvent extraction agents have been evaluated, including ethanol, methylene chloride, isopropanol. The objective of this study is to investigate the use of surfactants to extract corn oil from germ. Anionic surfactants with different structures (i.e.; chain length, EOs, POs) were used and the effect of structural properties on oil recovery efficiency will be presented. Surfactant based microemulsions will be studied by evaluating the effects of salinity and surfactant concentration on IFT. Extraction studies will be evaluated by assessing corn germ extraction efficiency both below and above the surfactant system critical microemulsion concentration (CμC). Size distribution of the corn germs and the solid/liquid ratio are other parameters that will be considered. Optimized parameters will be recommended for maximum oil recovery with low salinity and surfactant concentration.

Extraction Method Affects Proximate Composition and Yield of Fatty Acids from Mango Kernels.
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The high production of mango (Mangifera indica) in Sinaloa Mexico is focused mainly to the US fresh market. However, around 60% of that is used by local processing industries to make mango juice and paste. Derived from that practice, they also generate an average of 50,000 ton of mango wastes. By properly using those wastes, besides reducing the risk of environmental contamination, food, feed or nutraceutical products could be manufactured. Considering that seed kernels nearly account for 50% of those wastes, the proximate composition of those kernels was evaluated. Mango samples cv Keitt were harvested from a local mango farm. The results for proximate composition showed 8.1% protein, 11.8% fat, 3.4% crude fiber and 2.3% ash. Acetone showed the highest yield for fat extraction over hexane and ethyl acetate. The fat obtained from mango kernels was similar to a conventional butter, indicating its high content in saturated and monosaturated fatty acids. The gas chromatograph was used to evaluate the fatty acid profile, showing stearic, oleic, linoleic and palmitic acids. Atomic absorption results showed potassium, phosphorus and calcium, as the main minerals. The fatty acids from mango seed kernel cv Keitt showed high potential as good nutrient source in the human and animal diets.

Characterization of Milk Fat Globule Membrane Phospholipids Liposome.

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Liposome technology has been well developed in pharmaceutical industry as a drug delivery, but its application in food industry as a delivery system for nutraceuticals . Liposome can stabilize nutraceuticals against a range of environmental changes. Liposomes have the unique property of being capable of carrying both water-soluble and oil- or fat-soluble compounds within a single particle. Mostly they are prepared by soy or egg phospholipids but in this research the liposome is made by using MFGM (Milk Fat Globule Membrane) phospholipids, as milk phospholipids have unique properties and nutritional benefits and also can be obtained from butter milk, a waste stream of dairy industry. In this work, liposomes have been made by milk fat phospholipids, using high pressure homogenizers and the characterizations of the liposome have been studied. This technique is a new application for milk phospholipids and can be applied for nuraceuticals delivery in food system.

Effect of Emulsifier and Shearing Rate on Textural Properties of W/O Emulsions Processed in Scraped Surface Heat Exchanger.

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Physical properties of crystallized water-in-oil emulsions (W/O-e) are important for shelf life and consumer perception. These properties are determined by the chemical composition of the continuous and dispersed phase, and by processing conditions. This research studied the effects of shear (100 and 300 rpm), emulsifier (0-0.4%) and water content (20 and 40%) on the thermo-mechanical properties of milkfat:sunflower-oil (7:3) W/O-e processed in a scraped surface heat crystallizer. The crystallized emulsions were characterized at the exit of the crystallizer (t=0 h, 12°C) and after 24 h of storage (4°C). Results indicated that at t=0 h the 0.1% and 0.4% emulsifier concentrations decreased the solid fat content (SFC) and promoted the crystallization of high-melting TAGS compared to emulsions processed with 0% emulsifier. After 24 h of storage at 4°C the SFC increased due to crystallization of medium-melting TAGS from milkfat. The increase in shear (100 to 300 RPM) resulted in softer emulsion at t=0 h, but during storage the crystallization of medium-melting TAGS crystals increased the hardness. High water content and small droplets increased the overall hardness of the emulsions at t=0 h; however, once emulsions reached equilibrium during storage, the droplet size had no effect with the hardest emulsions having low water content.