2020 AOCS Annual Meeting & Expo Edible Applications Technology Abstracts

June 29 to July 3, 2020

Hosted online by the American Oil Chemists' Society (AOCS)

For more information, please visit https://annualmeeting.aocs.org.

Presentations dated Friday, January 1, 2021, were provided on-demand.

Edible Applications Technology

Monday, June 29, 2020

Session Time: 10:25 AM - 12:35 PM

Presentation Time: 10:30 AM - 10:55 AM

Track: Edible Applications Technology

(3733) Statistical mass fractals in flocculated foods. Are these useful parameters to measure?

Presenting Author: Fernanda Peyronel, PhD - University of Guelph

Flocculation of colloidal food arises from the random collision of small primary particles which coagulate to form larger aggregates that could eventually lead to the formation of a solid network. In some cases, the structures that arise are fractal in nature. A fractal structure is one that is scale invariant on "all" length scales but which, in practice, is not so. Scattering techniques, like X-rays, are powerful methods well suited to carry out this kind of measurement. For many years, X-rays have been used to identify the existence of statistical fractals in a range of complex systems e.g. colloids, aerosols and edible fats. The measurement of a mass fractal dimension in soft food materials, like edible fats and oils, is relatively new. This work will show the findings in complex systems like chocolate and waxes as well as present a summary of results from the literature in the area of edible fats and oil studied using X-ray scattering techniques on length scales ranging from hundred of nanometers to approximately 10 micrometers. We will show how the statistical mass fractal dimension can be extracted from the data collected using X-ray scattering. We will relate the fractal dimensions deduced to the characteristic length scales and we will discuss how the statistical mass fractal dimension could be affected by differences in processing or storage conditions.

Monday, June 29, 2020
Session Time: 10:25 AM - 12:35 PM

Presentation Time: 11:20 AM - 11:45 AM

Track: Edible Applications Technology

(3721) Crystal memory near discontinuous triacylglycerol phase transitions: models, metastable regimes and critical points

Presenting Author: David A. Pink, PhD - St Francis Xavier University

It is proposed that “crystal memory”, observed in the solid-liquid phase transition of saturated triacylglycerol (TAG) molecules, is due to the coexistence of solid TAG crystals and liquid TAG molecules, in a superheated metastable regime. In the superheated regime of a system exhibiting a single phase transition, solid crystals can act as heterogeneous nuclei onto which molecules can condense as the temperature is lowered after the system has been heated. This process is interpreted as a “crystal memory” effect. We outline a mathematical model, with a single phase transition, that shows how the observations can be explained, makes predictions and relates them to recent experimental data. A modified Vogel-Fulcher-Tammann (VFT) equation is used to predict time-temperature relations for the observation of “crystal memory” and to show boundaries beyond which “crystal memory” is not observed. The “holding time” is associated with the lifetime of a metastable state and a plot of lifetime versus temperature, using the modified VFT equation, is in agreement with recent data. The model possesses a critical point and we outline a procedure describing how it could be observed by changing the hydrocarbon chain length. We make predictions about how thermodynamic functions will change as the critical point is reached and as the system enters a crossover regime.

Monday, June 29, 2020
Session Time: 10:25 AM - 12:35 PM

Presentation Time: 11:45 AM - 12:10 PM

Track: Edible Applications Technology

(3725) Computing the Fractal Dimensions of Aggregates

Presenting Author: David A. Pink, PhD - St Francis Xavier University

A knowledge of the mass fractal dimension of aggregated solids in edible oils, for example, can provide us with an understanding of the factors which affect diffusion in such systems and the system’s response to shear, such as identifying the boundaries of shear banding. Mass fractal values can also guide the manufacture of new products when looking to replace one of the ingredients. Some of the techniques which have been used to characterize fractal structures in edible fats and oils are (1) light microscopy and the box counting method, (2) neutron scattering and (3) X-ray scattering. The box counting method relies on the scaling of two-dimensional images of the solid structures as functions of the size of areas that become progressively smaller, while scattering methods rely on an interpretation of the scattering intensity, I(q), or the structure

function, S(q), as a function of the scattering vector q. This talk will present a brief overview of the mathematics of these techniques and show how erroneous conclusions can arise from their use. Questions regarding, for example, (a) the discarding of information by dimensional reduction of the experimental data, (b) the ignoring of aspects of polydispersity in the experimental samples, and (c) the use of insufficient I(q) data, will be addressed. The perils associated with these approaches will be illustrated by computer simulation and animated graphics.

Monday, June 29, 2020
Session Time: 10:25 AM - 12:35 PM

Presentation Time: 12:10 PM - 12:10 PM

Track: Edible Applications Technology

(3903) Effects of Tripalmitin and Tristearin on Crystallization and Melting Behaviour of Coconut Oil

Presenting Author: Hironori Hondoh, PhD - University of Shizuoka

High melting fraction in natural oil will be crystallized first when oil is cooled, and the crystallization of low melting fraction can be affected by these crystals. Thus we investigated the effects of triacylglycerol additive (0.3–10 wt.%) and cooling rates (2°C, 5°C, and 10°C min−1) on the crystallization and melting behavior of coconut oil (CO)[1]. The polymorphism was investigated using synchrotron radiation X-ray diffraction (SR-XRD). From the DSC results, two exothermic peaks for CO crystallization indicated two compositions in CO. SR-XRD revealed that the α form crystallized first at a high crystallization temperature (HTc) followed by β′ crystallization at low temperature (LTc). Both HTc-α and LTc-β′ transformed into the β′ form of CO (CO-β′) solid solution during heating. Although the addition of PPP increased crystallization temperature of CO, PPP did not change CO polymorphism. However, during slow cooling with the StStSt additive, CO-β′ crystallization was induced from the melt directly. The difference between triacylglycerol and emulsifier in crystallization promotion will be discussed with our recent works [2,3]. Reference [1] Mahisanunt, B.; Hondoh, H.; Ueno, S. J. Am. Oil Chem. Soc., 96, 391-404 (2019). [2] Ishibashi, C.; Hondoh, H.; Ueno, S. Cryst. Growth Des., 17, 6363-6371 (2017). [3] Ishibashi, C.; Hondoh, H.; Ueno, S. J. Am. Oil Chem. Soc., 95, 709-720 (2018).

Tuesday, June 30, 2020
Session Time: 8:25 AM - 11:45 AM

Presentation Time: 8:25 AM - 8:30 AM

Track: Edible Applications Technology

Introduction: Structuring of Liquid Oil for Low SAFA and Non-trans Applications

Co-Chair: Sarah Willett, University of Georgia, USA - University of Georgia
Co-Chair: Karel Hrncirik, PhD - Upfield

The removal of trans fat and reduction of saturated fats have encouraged the study of alternatives for structuring vegetable oils. This session discusses the compounds and techniques proposed for structuring liquid oils or emulsions and the physicochemical and/or functional properties of these systems. The session includes studies using edible waxes, wax esters, phospholipids, cellulose derivatives, etc., and using principles of lipid gel formation.

Tuesday, June 30, 2020
Session Time: 8:25 AM - 11:45 AM

Presentation Time: 10:30 AM - 10:55 AM

Track: Edible Applications Technology

(3737) Characterizing and modelling novel rice bran wax and gelatin bigels to determine structure

Presenting Author: Ariana Saffold - Iowa State University

A bigel is a biphasic system that is composed of an organogel and hydrogel. Bigel advantages in comparison to both types of gels alone include greater stability, better skin compatibility, and the ability to carry lipophilic and hydrophilic substances. The objective of this study was to characterize the thermal, mechanical and structural properties, as well as chemical interactions between components of formulated bigels. A combination of a gelatin hydrogel and rice bran wax-based organogel with soybean oil as the continuous phase was used for bigel preparation. Bigels were formulated with different hydrogelator (gelatin) concentrations and organogel to hydrogel (OG:HG) ratios. Two gelatin concentrations (5 and 7 wt%) were used to prepare four bigels (for each concentration) of varying OG:HG ratios (50:50, 40:60, 30:70, 20:80). The organogelator concentration remained as 10 wt% rice bran wax for all samples. Bigels were analyzed using Fourier transform infrared spectroscopy (FTIR), differential scanning calorimeter (DSC), confocal laser scanning microscopy (CLSM) and small deformation rheology. Confocal microscopy images confirmed an organogel-in-hydrogel system for all OG:HG ratios. An increase in organogel content increased the interaction between organogel droplets, leading to a more structured bigel. This was also confirmed by rheology frequency sweeps where 50:50 and 40:60 ratios had the highest storage (G') modulus values. FTIR and DSC showed no unique peaks from interaction between components meaning the system is a "true" bigel that is kinetically stable. A modified Boltzmann Sigmoidal equation fit the model rheological behavior

of the samples. The successful characterization of this system can be used to tailor its properties for specific applications in the food, pharmaceutical and cosmetic industries.

Tuesday, June 30, 2020
Session Time: 8:25 AM - 11:45 AM

Presentation Time: 11:20 AM - 11:45 AM

Track: Edible Applications Technology

(4143) Engineering the plasticity of wax-based oleogels

Presenting Author: Megan E. Govers, University of Guelph, Canada - University of Guelph

The structuring of oleogels using mixed crystalline gelators was investigated as a potential means of improving the functionality of wax-based oleogels, as such systems tend to exhibit brittle mechanical flow behavior. The impact of combining white beeswax (WBX) and mixed mono- and diglycerides (MDG) were thus compared to oils structured with WBX alone using 15% structurant in high oleic sunflower oil. Mixed gelator oleogels were structured with a 2:1 WBX/MDG ratio and exhibited more desirable mechanical properties compared to those structured with WBX alone. Thermal analysis showed eutectic behavior in the mixed system, indicating independent crystallization of WBX and MDG. Microstructural analysis demonstrated smaller, clustered needles dominated the mixed WBX/MDG oleogels, while larger, singular needles were observed in oleogels structured with WBX alone. Large deformation flow profiles demonstrated the addition of MDG to the WBX crystal network increased plasticity, without compromising mechanical strength. This effect was attributed to the fact that plastic deformation mechanisms of polycrystalline materials are grain size dependent. Smaller microstructural grains are known to induce more plastic behavior, which correlated with the increased plasticity observed in the mixed WBX/MGD system. Changes in plasticity were observed during storage and could be correlated to observed changes in grain sizes. These results indicate the incompatibility between WBX and MDG impacts the microstructure of the resulting crystalline network, which has direct implications on the functional properties of the bulk material. Specifically, the ability to increase plasticity without compromising mechanical strength may have direct applications for mimicking specialty fats.

Tuesday, June 30, 2020
Session Time: 11:40 AM - 12:35 PM

Presentation Time: 11:40 AM - 11:45 AM

Track: Edible Applications Technology

Introduction: Implication of Lipid Structuring and Fat Crystallization in Food Application

Co-Chair: Nuria C. Acevedo, PhD - Iowa State University
Co-Chair: ELENA DIBILDOX-ALVARADO, PhD - UNIVERSIDAD AUTONOMA DE SAN LUIS POTOSI. FACULTAD DE CIENCIAS QUIMICAS

Application of fat crystallization can be seen in all segments of the food industry. This session discusses the implication and utilization of fat crystallization in food applications for textural and organoleptic attributes, including role of fat selection, role of food ingredients and effect of food processing on product structuring for confectionery, bakery, margarines, ice cream, and so forth.

Wednesday, July 1, 2020
Session Time: 10:25 AM - 1:25 PM

Presentation Time: 11:20 AM - 11:45 AM

Track: Edible Applications Technology

(3749) Effects of degree of deacetylation and concentration of chitosan on the rheology and functional properties of Citrem-chitosan-stabilized bilayer nanoemulsions

Presenting Author: Kunal Kadiya, M.Tech - University of Saskatchewan

In emulsion gels, flow behaviour could be restricted due to repulsive jamming or attractive droplet aggregation. For nanoemulsions, repulsive jamming could be induced by decreasing droplet size and increasing interfacial shell-layer thickness. In this work positively charged chitosan with different degree of deacetylation (DDA 50 and 93%) was used to form bilayer electrostatic deposition on negatively charged Citrem (citric acid esters of monoglycerides)-stabilized oil droplets with the aim to determine the influence of interfacial shell-layer on repulsive gelation. The primary Citrem-stabilized liquid nanoemulsions (d_{32}<200 nm) were prepared by high-pressure homogenization. After removal of excess Citrem by multiple centrifugations, secondary nanoemulsions were fabricated by adding different concentrations (0-0.25wt%) of chitosan at pH 4. With an increase in DDA93 chitosan concentration, negative charge (-48.0mV) of primary emulsion decreased to zero at 0.075wt%, increased to +51.9mV at 0.2wt% and remained unchanged thereafter. However, DDA50 chitosan showed a lower magnitude of positive charge and reached a maximum of +40.1mV at 0.2wt%. Accordingly, the microstructure changed from free-flowing Citrem-stabilized nanodroplets to aggregated droplets at ≤0.15wt%, and uniformly coated droplets at ≥0.2wt% chitosan. Emulsion viscoelasticity also went through a maximum which could be attributed to weak gels without chitosan, followed by strong aggregated gels between 0.05-0.15wt% chitosan, and smooth gels beyond 0.2wt% chitosan. With DDA50, viscoelastic maxima shifted towards a higher concentration of chitosan.

Lipid digestibility of all bilayer nanoemulsions was decreased significantly compared to the primary nanoemulsion. Such gelation in bilayer nanoemulsions using a combined electrostatic and steric repulsion can serve as an attractive option to produce low-fat products.

Wednesday, July 1, 2020
Session Time: 10:25 AM - 1:25 PM

Presentation Time: 11:45 AM - 12:10 PM

Track: Edible Applications Technology

(3750) Stabilization of food-grade liquid water-in-vegetable oil emulsions by modifying emulsifier interactions at the oil-water interface

Presenting Author: Maria F. Romero-Pena, PhD. Candidate - University of Saskatchewan

Maria Romero(1,2), Dérick Rousseau(3), and Supratim Ghosh(4) (1)Dept. of Food and Bioproduct Sciences, College of Agriculture and Bioresources, University of Saskatchewan, Canada (2)Escuela Superior Politécnica del Litoral, ESPOL, Facultad de Ingeniería en Mecánica y Ciencias de la Producción, Ecuador. (3)Ryerson University, Canada (4)University of Saskatchewan, Canada Food-grade water-in-vegetable oil (W/VO) emulsions are difficult to stabilize with only glycerol monooleate (GMO), which desorbed from the water-VO interface due to their stronger hydrogen bonding with VO fatty acid carboxylic groups. We hypothesized that stronger hydrogen bonding towards the aqueous phase would enhance GMO's binding to the interface, thereby providing stability to the emulsion. Therefore, carboxylic group donating agents such as citric acid (CA), ascorbic acid (AA) were added to the aqueous phase to stabilize W/VO emulsions with GMO. Various concentrations of CA, AA and NaCl were added to the aqueous phase. W/VO emulsions (20/80wt%) were prepared by high-pressure homogenization. Emulsions were stored for seven days; the stability was identified by visual observation, sedimentation, viscoelasticity, microstructure, and droplet size. A minimum of 0.125wt% NaCl was needed for emulsion stability when no CA or AA was present. The addition of CA or AA improved stability without the presence of salt. All emulsions behaved like weak gels, where G' increment with NaCl. The addition of acids significantly increased G' at most concentrations. After seven days, the presence of CA, G' remained unchanged, except a rise was observed at high NaCl. With AA, a decrease in G' was observed, indicating droplet destabilization, except an increase, was found at 1wt% salt and 5wt% AA. Microscopy showed droplet aggregation at low NaCl without the acids. In the presence of the acids, no droplet aggregation was observed. This study demonstrates stable liquid W/VO emulsions can be developed based on emulsifier interactions at the oil-water interface.

Thursday, July 2, 2020
Session Time: 8:25 AM - 12:10 PM

Presentation Time: 8:30 AM - 8:55 AM

Track: Edible Applications Technology

(3518) The Addition of Selected Minor Oil Components to Pure Triglyceride Oils Modify the Properties of β-sitosterol/γ-oryzanol Oleogels

Presenting Author: Maria Scharfe, MA - Technical University Berlin

The physical properties of oleogels can be manipulated, inter alia, by the type of oil used. Although the influence of solvent composition has been recognized, the detailed mechanisms contributing to the changes in e.g. gel hardness have not yet been unraveled in detail. It was shown previously that a variation of the fatty acid composition as well as the presence of polar molecules (PM) alternate the appearance of the elements of scaffolding (tubule) of β-sitosterol/γ-oryzanol oleogels. These PM may be of natural origin or formed during oil deterioration. AFM revealed that the spatial arrangement of tubules differed in the absence or presence of PM. It is thus believed that PM concentrate at the surface of primary building blocks and modify the nature of their interaction. To further address this question the elimination of polar oil components from vegetable oils is inevitable. This was realized by subjecting canola, sunflower and flaxseed oil to a column chromatography procedure. In a second step selected PM were added to the oils at 3 different concentrations (1; 2,5 and 5 wt%) and their impact on oleogel hardness, microstructure and thermal behavior was investigated. Depending on the type of additive different effects on gel hardness, gel-sol transition temperature and enthalpy were observed. The results were put into context with common oil quality parameters such as POV, water content and fatty acid composition. The results obtained in this study will provide additional insights on the role of minor components on oleogel properties.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology

(3598) Functional Fat Blends of Specific Mixture Systems of Saturated-Oleic Mixed Acid Triacylglycerols: Impact of Molecular Compound Crystal Formation

Presenting Author: Kiyotaka Sato - Hiroshima University

Critically increasing high demands for trans-free and reduction of saturated fats have been asking lipid researchers to develop novel ideas of materials designs of hard stocks for various edible fats. The uses of edible oleogels and interesterification of natural fats are highly promising candidates. In addition, fat blending technology based on natural fat resources containing monounsaturated fatty acid moieties has also been developed. Among three typical fat mixture phases of miscible, eutectic and molecular compound (MC) crystal forming systems, recent

studies have shown the high potential of the application of the MC-crystal forming mixture systems in fat spread and confectionery fats. This is because MC crystals are formed by specific molecular interactions among cis-monounsaturated fatty acids moieties. The MC-crystals-based fat blends, therefore, can increase the relative concentrations of unsaturated fatty acids at the expense of saturated ones, possibly making important physical properties such as polymorphism, melting and hardness suitable for edible applications. The present paper first discusses key molecular interactions forming the MC crystals, particularly oleic-oleic aliphatic interactions and steric hindrance between glycerol group and methyl end stacking, which are the main drivers for the formation of MC crystals having double chain length structures and stable polymorphic forms. Then, the kinetics of polymorphic transformation and crystallization of stable form of the MC crystals with saturated-oleic mixed acid triacylglycerols (POP/OPO and POP/PPO) are shown by using synchrotron X-ray diffraction and DSC methods.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology

(3647) Co-crystallization properties of PPP, POP, OPP and POO and palm oil dry fractionation

Presenting Author: Veronique J. Gibon, PhD in Chemistry - Desmet Ballestra Group SA

Due to its unique triglyceride composition, palm oil has the particularity of being semi-solid at room temperature. Major fatty acids are palmitic and oleic types, PPP, POP and POO being the most abundant tri-saturated, mono-unsaturated and di-unsaturated triglycerides, respectively. It is also the most fractionated oil worldwide, mostly in multi-step operations. Dry fractionation is a process that combines crystallization and separation of partially crystallized oil; in the case of palm oil, the main triglycerides involved are obviously PPP, POP and POO. However, crude palm oil also contains a certain proportion of asymmetrical isomers like OPP, that is sometimes modified by the refining process. Adverse effects of excessive OPP are reflected in the crystallization properties of the produced solid and liquid fractions but it also affects the dry fractionation process. It is therefore fundamental to understand at a molecular level the interactions involved. This presentation will detail and compare the binary phase diagrams of several systems: PPP-POP, PPP-OPP; PPP-POO, POP-POO, OPP-POO and POP-OPP, obtained by combining differential scanning calorimetry and variable temperature powder X-ray diffraction. Molecular interactions will be analyzed in dynamic mode (heating after quenching) and after tempering (heating after few months stabilization at room temperature). The ternary phase diagrams PPP/POP/POO and PPP/OPP/POO will give a complementary representation in terms of isothermal melting lines showing that co-crystallization behavior of POP and OPP within PPP and POO is different. Best understanding of these molecular interactions is critical for perspicacious carrying out of the palm oil dry fractionation process.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology

(4176) Filterability of Oil Slurries as a Function of Particle-Size Distribution

Presenting Author: Jeppe Lindegaard Hjorth - AAK Denmark A/S

Objective In dry fractionation, the filterability of an oil slurry determines the quality of the separation, the quality of the resulting fractions and thus the profitability of the process. Therefore, this parameter is pivotal for obtaining the best and most efficient fractionation. To date the quality of a dry fractionation process has indirectly been assessed by comparing viscosity and SFC of the oil slurry. In this study, it was evaluated whether specific features from the crystal-size distribution of a given oil slurry could be correlated directly to the observed filterability. Methods Filterability, SFC, viscosity and crystal-size distribution were measured for a number of fractionation experiments with different isothermal holding temperatures and crystallization times. The filterability was described as filtered volume of olein per time and the crystal-size distribution was measured continuously using Mettler Toledo's Particle Track equipment. Results A strong correlation was observed between the filterability and the quality of the stearin cake. The crystal-size distribution changed significantly based on the length and isothermal temperature of the experiment. By assuming spherical geometry and calculating total-surface area and volume of the crystals it was possible to describe the observed SFC and viscosity and furthermore there was a good correlation between the total crystal-surface area and the filterability. Conclusion The measured crystal-size distribution could be translated into meaningful physical properties of the oil slurry in question. Said distribution can therefore be used as a time-dependent output to follow the crystallization process and pinpoint optimal filterability.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology

(3638) Application and Characterization of Oleogels Based on Rapeseed Oil for the Production of Fine Bakery Products

Presenting Author: Bertrand Matthäus - Max-Rubner-Institut
Presenting Author: Jacquelyn Cheng - DuPont Nutrition & Biosciences

Fine bakery products are characterized by a high fat content of at least 10% fat that consists of hardened fats, bakery margarines or natural solid or semi-solid fats for giving the dough a suitable plasticity and malleability resulting in a proper texture, rheology, taste and shelf life of the final product. Due to rejection of hardened fats by consumers and an ongoing discussion

regarding ecological and health aspects of palm oil, the search for alternative fat phases for the production of fine bakery products is still up to date. A promising alternative to usually used fat phases are oleogels based on rapeseed oil and organogelators such as ethyl cellulose, monoacylglycerols or waxes that combine the positive nutritional properties of rapeseed oil by optimizing the fatty acid composition with the technological properties of solid or semi-solid fats necessary for the production of fine bakery products. In the presented work different commercially available fat phases for the production of fine bakery products were characterized with regard to their thermodynamical behavior, texture and rheological characteristics and compared to functional properties of oleogels as function of cooling rate during oleogelation, additives and the fatty acid composition of the oil. For different types of fine bakery products, such as cookies or muffins, it was shown that the application of rapeseed oil based oleogels instead of commonly used fat phases, resulted in a comparable quality of the ready-to-eat products. A sensory consumer test revealed a broad agreement with the products by consumer.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology

(3694) Novel cocoa butter equivalents form microalgal butters

Presenting Author: Saeed M. Ghazani, PhD - University of Guelph

Two Chlorellae sp. microalgae-derived algal butters were selected as base-stocks for cocoa butter equivalent manufacture. After extraction and refining of the algal butter (degummed, neutralized, bleached and deodorized), acetone solvent fractionation was carried out to obtain two algal butter fractions, one high in SOS (algal stearin) and the other high in POP and POS (algal mid-fraction). After optimizing the blending ratio (15:85% w/w stearin;mid-fraction), the amount of POP, POS, and SOS (the main triacylglycerols in cocoa butter) in the algal butter CBE was 15.9%, 31.7%, and 22.8%, respectively. The melting point and melting enthalpy of the algal CBE were not significantly different from those of CB (33.6 oC for CB compare to 32.3 oC for CBE). The crystal polymorphic form of the algal butter was also similar to that of form V of CB (β2-3L) with characteristic WAXS reflections at 4.61 Å (vs), 4.01 Å (w), 3.91 Å (m), 3.77 Å (m), 3.7 Å (m). This novel algal CBE was used to make dark chocolate and its sensory characteristics compared to chocolate made with cocoa butter. This study demonstrates the potential for producing a cocoa butter equivalent from microalgal oils.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology

(3726) Structuration and physical properties of mixed-oleogels for commercial shortenings substitution

Presenting Author: JAIME D. PÉREZ-MARTÍNEZ, PhD - UNIVERSIDAD AUTONOMA DE SAN LUIS POTOSI

The gelation process and rheology of oleogels produced with ethyl cellulose (EC; 4, 8 or 12%), monoglycerides (MG; 5%), and candelilla wax (CW; 0 or 3%) were assessed by oscillatory rheology and differential scanning calorimetry. EC oleogels produced without MG showed grainy texture because EC could not be fully dissolved in vegetable oil at 150 °C. After applying a protocol to eliminate the crystalline fraction from EC and mixing 5% MG, EC oleogels were smooth. The added MG decreased the resistance to deformation and increased the fluid-like character of EC solutions at > 20 °C. On the other hand, the EC polymeric network and MG and CW crystals had a positive interaction on the consistency of mixed-oleogels. The mechanical recovery after shearing (10 s^{-1} for 1 min) reached 100% of the G' obtained under static conditions for EC oleogels produced with MG. This phenomenon was associated with the hydrogen bonding among EC chains mediated by hydroxyl groups of MG, forming junction zones of the type EC-$[MG]_n$-EC. Thus, when these bonds were broken by shearing, it could be reformed as there was a large amount of MG molecules available in the solvent. Mixed-oleogels showed viscoelastic properties similar to the fat phase of stick, Danish and puff pastry margarine, before and after shearing.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology

(3609) Insights into the Assembly Mechanism of Multi-Component (Ceramide + Lecithin + Water) Oleogels: Influence of Homogenization Temperature

Presenting Author: Yaqi Lan - South China Agricultural University

A mixture of ceramide and lecithin at specific ratios was capable of forming oleogels in sunflower oil triggered by adding trace amount of water. It was noted that the addition of water at different homogenization temperature (Tw) resulted in different gelation behavior and microstructure. To better illuminate the assembly mechanism at different homogenization temperature, samples with water added at different Tw (20°C, 45°C, 70°C and 95°C) were prepared. The viscoelastic properties, microstructures, as well as the crystal packing of these samples were investigated. It was observed that all samples prepared at Tw of 20°C and 95°C

formed gels, while most samples prepared at Tw of 45°C and 70°C were too weak to form gels. Gels prepared at 95°C are stronger but more fragile in texture compared to gels produced at 20°C. The crystal morphology of gels drastically changed with homogenization temperature. Spindle-shaped crystals were observed in gels prepared at low Tw (20°C). While gels prepared at high Tw (95°C) exhibited a network with packed oil droplets stabilized by lamellar shells together with fibrillar crystals in the bulk phase. Our hypothesized assembly mechanism can be concluded as: the increasing Tw resulted in the conversion of CER and LEC crystallization from co-assembly (Tw=20°C) to self-sorting by individual gelators (Tw=95°C). In this study, novel water-induced oleogels were produced by manipulating homogenization temperature, and such information further assists the rational design of lipid-based healthy fat products.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology

(4175) The Effects of Shear and Dispersed Particles on the Thermal Behavior of Palm Oil

Presenting Author: Dérick Rousseau - Ryerson University, Toronto,

While palm oil has proven to be a reliable ingredient for the formulation of biscuits, cream fillings, and compound chocolates, our understanding of its thermal behaviour continues to be limited, especially when processing conditions important to the food industry (e.g., shear, temperature, presence of secondary ingredients) are taken in consideration. In this study, we explored the effects of shear (e.g., 0-500 RPM) as well as dispersion concentration (e.g., 0-5 wt.%) and surface chemistry [i.e., hydrophilic (silica) or hydrophobic (octadecyl-silica)] on the thermal properties of commercial palm oil cooled from 60 to 20 °C at 1°C/min. With this crystallization regime under quiescent conditions and in the absence of dispersed particles, four endotherms were present. The highest-melting endotherm (~ 43°C) appeared to be most separated from the other endotherms and was completely removed from the thermal profile as both dispersion concentration and shear speed increased, which suggested that the higher-melting triglycerides were completely incorporated into lower-melting crystals. Under static crystallization (i.e., 0 RPM), palm oil's total enthalpy of melting increased from ~ 7 J/g to either ~ 12 or 13 J/g as the dispersion concentration increased from 0 to 5 wt.% for silica and C18-silica, respectively. While crystallization was enhanced in the presence of C18-silica, due to its favourable, hydrophobic surface, silica was still able to promote heterogeneous nucleation, even though its surface is considered hydrophilic. Any difference between silica and C18-silica on the total enthalpy of melting was reduced as shear was applied, which suggested that, under the presence experimental conditions, palm oil melting was primarily driven by shear, followed by dispersion concentration, and lastly surface chemistry.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology

(3899) Wax-based Oleogels – Deciphering the Molecular Composition Functionality Relation

Presenting Author: Eckhard Flöter - Technical University Berlin

Non-triglyceride oil structuring has gained a significant momentum in the past decade. The motivation to replace the traditional oil structuring method by fat crystals typically based on highly saturated triglycerides is multifaceted. It ranges from the need to overcome partial hydrogenation to avoiding palm oil due to consumer concerns relating to sustainability considerations. From the raft of structuring systems that have been identified waxes appear to be most frequently studied. The long list of binary wax-oil combinations is extended by application of mixed structuring systems. However, the term wax appears to be a rather unspecific description for a range of materials originating from different plant or animal origin. In order to create a more comprehensive approach to this area it is necessary to better characterize raw materials to develop a reliable understanding of the composition functionality relations. To this end waxes originating from different origin were mixed with each other and their respective hydrolysates. This to map functionality in the ester, fatty alcohol, fatty acid space. The later binary system being an identified structuring system in itself (Gandolfo et al. 2004). In summary, significant differences between the different mixtures were found and also persisted during extended sample storage. An attempt to generalize this approach beyond the own data gathered will be discussed as well.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology

(4154) Structuring Edible Oils with Hydrocolloids: Where do we stand?

Presenting Author: Ashok R. Patel - Guangdong Technion Israel Institute of Technology

The versatile texturing properties of hydrocolloids have played a vital role in revolutionizing the processed food industry through the development of innovative formulations of water-based food products. Unfortunately, the use of hydrocolloids in structuring lipid-continuous food products has not yet been fully explored. Structuring of liquid oil with hydrocolloids is a promising approach because there are many polymers that are approved for use in foods. However, since, most of the food hydrocolloids are inherently hydrophilic in nature, they are ineffective in structuring oils due to their limited dispersion. Indirect approaches that work on creating a pre-formed structural framework, are increasingly been explored to exploit the structuring properties

of hydrocolloids in liquid oils. In this talk, I would like to briefly discuss the evolution of the field of hydrocolloids-based oil structuring with the help of some illustrative examples of new and current research in this field. Specifically, discussion will be focused on the evolution of the soft matter approaches that are based on the use of aqueous-based colloids as sacrificial templates to force amphiphilic hydrocolloids (proteins and polysaccharides) to structure edible oils. Concise information on the formation, characterization and edible applications of structured oils based on varied templates such as foams, complex emulsions (concentrated, Pickering-stabilized, and high internal phase emulsions), hydrogels as well as aerogels will be shared in the talk.

Wednesday, July 1, 2020

Session Time: 10:25 AM - 1:25 PM

Presentation Time: 10:55 AM - 11:20 AM

Track: Edible Applications Technology@@@Analytical

(3612) Understanding Bubble Dynamics in Sonicated Edible Lipids to Improve Their Physicochemical Properties

Presenting Author: Jack J. YOUNGS, MChem - University of Southampton

High-intensity ultrasound (HIU) has been employed within edible lipids to accelerate the crystallisation process and to enhance the physicochemical properties of the resulting solid. Several studies have highlighted the significance of the generation of gas cavities during sonication, however acoustic cavitation has received little research interest for lipids. High-speed imaging has shown that the dynamics of a stable cavitation cluster next to a piston-like emitter (PLE) are driven by the HIU power level. The kinetics of lipid crystallisation for a sequence of cavitation clusters within an all-purpose shortening sample were investigated. The influence of the cluster dynamics upon the crystallisation kinetics is shown to become less significant for greater lipid supercooling at 26 °C compared to 30 °C. In addition, a bifurcated streamer consisting of two cavitation clusters that oscillate with a relative phase shift of 180° with respect to one another was explored. This unusual ‘bi-cluster’, formed at a HIU power of 10 W, is shown to reduce the induction time of crystallisation by ~8 minutes with respect to the untreated lipid sample. This was comparable to higher HIU powers of up to 36 W. Finally, an increase in the hardness of the lipid sample was noted. The greatest hardness was reported in the presence of a cavitation cluster with the lowest frequency of oscillation. These results indicate the importance of studying cluster dynamics to enable a greater understanding of the lipid sonocrystallisation mechanism and this work may provide a route to tailor lipid crystallisation behaviour in future.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology@@@Analytical

(3551) Effects of Polymorphs of Seed Crystals on the Crystallization of Coconut Oil

Presenting Author: Busakorn Mahisanunt - Hiroshima University

The coconut oil (CO) has become popular in recent years because of their beneficial effects of medium-chain fatty acids on human health. Our previous study found that the tripalmitin (PPP) additive induced the heterogeneous nucleation of CO [1], but the effects of polymorphs of seed crystals on the CO crystallization have not been concerned yet. Therefore, we evaluated the influence of polymorphs of PPP seed crystals on the CO crystallization by seeding techniques. The PPP with three polymorphs (α, β', β_α forms) were used as seed materials. An annealed PPP powder (β_{ann}) was also used as the β form seed crystal. The CO crystallization on PPP seed crystals was investigated at 20ºC by differential interference contrast microscopy and synchrotron radiation X-ray diffraction. We found that all PPP seed crystals with different polymorphs promoted the nucleation of β' form of CO by heterogeneous nucleation. Because β' form seed crystals were the most effective accelerator, polymorphic matching between seed crystal and CO has strongly induce the nucleation of CO by epitaxial growth. A high melting fraction of CO grew on the surface of β_{ann} seed with the same orientation as the seed. These results indicate that the polymorphs of seed crystals significantly affect the efficiency of CO crystallization. The efficient seeding will have the advantage to improve the physical properties of CO by the fractionation process. Reference [1] Mahisanunt, B.; Hondoh, H.; Ueno, S. *J. Am. Oil Chem. Soc.* **96**, 391-404 (2019).

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology@@@Analytical

(3544) How Multiscale Structures in Milk Fat Shape the Crystal Network Formation

Presenting Author: Naomi Arita Merino - WAGENINGEN UNIVERSITY

Behind the rheological properties of milk fat (MF), there is an arrangement of multiscale structures with a great impact on the functionality and sensory properties of several products. To tailor those properties, we need the ability to control and predict the formation of crystal networks and their composing multiscale structures. We studied the network formation of MF crystallizing at different temperatures. We used small deformation oscillatory rheology and a combination of techniques to characterize the multiscale structures. We produced phase transition diagrams with information in a broad length scale: from the molecular level (TAG composition by GC) and the sub-cell level (polymorphism by WAXD), to the lamellar stacking

(by SAXS) and up to the morphology of their polycrystalline particles (by microscopy). This way, we liked temperature-dependent structural changes in the crystal network to its rheological evolution. Our rheological data revealed three-step network formations in addition to the typical one- and two-step crystallizations. This peculiar evolution was observed at intermediate temperatures and consistently concurrent with the formation of β polymorph. The transition between the second and third steps matched the transition from α to β and β' and lamellar thickness from 4.5 to 4 nm. The initial micrographs showed the formation and growth of 15 μm randomly oriented spherulites, while the polymorphic transition period was marked by the appearance of 50-75 μm highly branched spherulites. These two spherulites composed the final networks formed through three-step processes, while the one- and two-step formed networks displayed only one type of polycrysltalline particle.

Tuesday, June 30, 2020

Session Time: 8:25 AM - 11:45 AM

Presentation Time: 8:55 AM - 9:20 AM

Track: Edible Applications Technology@@@Health and Nutrition

(3585) Molecular Dynamics Simulations to Probe Fat Crystallization and Oleogel Structuring of Edible Oils

Presenting Author: Stephen R. Euston, PhD - Heriot-Watt University

Molecular simulation complements experimental studies of food systems by facilitating a molecular level understanding of structure formation. We have used both all-atom (AA) and coarse-grained (CG) molecular dynamics (MD) to follow the structural evolution of a crystallizing triacylglycerol (TAG) melt (using CG-MD) and the molecular details of phytosterol self-association in sterol-based oleogels (using AA-MD). For TAGs, CG-MD demonstrates substantial supercooling during crystal formation. When the crystal is subsequently heated, we can reproduce realistic melting temperatures for model tristearin and mixed tristearin+trilaurin systems. Additionally, information about the mechanism of the early stages of crystal formation can be deduced, and in particular the order of glycerol and acyl chain partitioning during cooling from the melt. In the oleogel systems, we model the formation of nanometre-sized tubules in a sterol ester (oryzanol, ORY) - sterol (β-sitosterol, SIT) mixture in an oil phase. We have identified the critical interactions between ORY and SIT that control tubule stability, the origin of water instability and the interactions that control hierarchical structuring into tubule bundles that form the network gel. This has informed our experimental studies that involve de-novo synthesis of novel gelators with the aim to control better the rheological (texture) properties and stability of oleogels in food products. The work demonstrates the applicability of molecular simulation to oil and fat related structural studies and should help to promote use of this approach by others in the future.

Tuesday, June 30, 2020
Session Time: 8:25 AM - 11:45 AM

Presentation Time: 9:20 AM - 9:45 AM

Track: Edible Applications Technology@@@Health and Nutrition

(3587) Understanding Self-Association and Tubule Formation in Phytosterol-Based Oleogels

Presenting Author: Stephen R. Euston, PhD - Heriot-Watt University

Mixtures of the sterol ester gamma-oryzanol (ORY) and the sterol beta-sitosterol (SIT) form helical tubules when mixed together in triglyceride oil. AFM imaging shows a hierarchical structure in the system. Initially, SIT and ORY form dimers, stabilised by a hydrogen bond, although there is evidence of a substantial energy barrier to nucleation. Molecular docking and FTIR confirms the H-bond and that the dimer adopts a staggered conformation due to the presence of an orthoganol methyl group on ORY that prevents parallel alignment of the sterane cores. This dimer self-assembles into a helical tubule, but it is unclear what drives the further self-association. The wedge shape, we believe, directs formation of a helical tubule as it creates a twist when consecutive dimers align. De-novo synthesised sterol ester analogues of ORY that lack both the orthogonal methyl group and the hydrogen bond form a parallel dimer and do not gel. Once formed tubules further associate into bundles. Raman, UV-Vis and CD spectroscopy show bundle formation is associated with vibrational modes in ferulic acid ester groups attached to ORY suggesting these start to aggregate. MD simulations of two tubules shows that ferulate groups of ORY protrude from the surface of tubules, and that π-π-stacking, vdW and H-bond interactions between the ferulates stick tubules together. A combination of experimental and simulation techniques allows elucidation of molecular features controlling phytosterols to act as oleogelators. With this knowledge we have begun to design and synthesise new olegelators de-novo to allow control over oleogel structure and properties.

Tuesday, June 30, 2020
Session Time: 10:25 AM - 12:35 PM

Presentation Time: 10:30 AM - 10:55 AM

Track: Edible Applications Technology@@@Health and Nutrition

(3775) Lipid Bioaccessibility of Cooked Meat using the Dynamic in-vitro Gastrointestinal TIM-1 Model

Presenting Author: Elizabeth A.L West - University of Guelph

The link between diet and health is profound. The overconsumption of foods rich in lipids is a significant factor contributing to obesity and has been linked to the increased incidence of chronic diseases such as type II diabetes, cardiovascular diseases and some cancers. The objective of this study was to investigate if a change in physical state induced by cooking alters the metabolic response of lipids in food. Lipid digestion of beef longissimus muscle cooked to

different temperatures was assessed utilizing the advanced TIM-1 simulated gastrointestinal tract, which is a dynamic in-vitro system that mimics human digestion. Digestion kinetics consisting of lipid digestion rate constants, induction times and bioaccessibility were measured over 6 hour simulated digestions. The changes in network structure of the different heat treatments were analyzed using rheology, differential scanning calorimetry, Fourier-transform infrared spectroscopy and confocal microscopy. Preliminary results show significant differences in lipid digestion between raw and cooked meat. This research will enable a better understanding of the mechanisms of digestion with relation to changes in food structure and matrices due to processing; ultimately serving in the development of foods that minimize the amount of free fatty acid release, which could help prevent metabolic diseases associated with lipid intake and their resulting health complications.

Wednesday, July 1, 2020
Session Time: 10:25 AM - 1:25 PM

Presentation Time: 10:30 AM - 10:55 AM

Track: Edible Applications Technology@@@Health and Nutrition

(3542) Impact of Various Physicochemical Factors on Stability of Curcumin in Oil-in-water Emulsions

Presenting Author: Mahesh M. Kharat, PhD - University of Massachusetts Amherst

The aim of this study was to study the effect of different physicochemical factors on the stability of curcumin in oil-in-water emulsions. Curcumin was incorporated in aqueous or emulsions systems and its stability was measured over time. Pure curcumin degraded quickly in alkaline aqueous solutions and crystallized out in acidic aqueous environments. Its water dispersibility and chemical stability were improved by incorporation into oil-in-water emulsions. Curcumin retention was >85% at pH < 7.0, whereas 62, 60, and 53% were retained by emulsions stored at pH 7.0, 7.4, and 8.0, respectively (37 °C, 1 month). It was found that curcumin transfer could occur in such a system from the protective oil phase to the detrimental aqueous phase causing curcumin degradation in emulsions. It was also found that degradation occurs at a faster rate as the droplet surface area increased. This may be mainly due to increased curcumin transfer from oil to the aqueous phase and/or enhanced interfacial exposure to hydroxyl ions, and oxygen responsible for chemical degradation. Finally, the extent of curcumin degradation in emulsions fabricated using four different emulsifiers decreased in the following order: saponins >> gum arabic ≈ casinate ≈ Tween 80 after storage at 55 °C for 15 days, suggesting that curcumin degradation was accelerated in saponin stabilized emulsions. This study established that the stability of curcumin is affected by various physicochemical parameters, and it may be important to optimize emulsions with respect to emulsifier type, mean droplet size to achieve higher curcumin retention.

Wednesday, July 1, 2020
Session Time: 10:25 AM - 1:25 PM

Presentation Time: 12:35 PM - 1:00 PM

Track: Edible Applications Technology@@@Health and Nutrition

(3715) Increasing the Oral Bioaccessibility of Curcumin using Oleogels Structured by Rice Bran Wax

Presenting Author: Farnaz Maleky - The Ohio State University

Curcumin, the bioactive compound found in turmeric, exhibits a wide range of health-promoting properties. However, its application in food and medicine is limited by its poor bioaccessibility. The purpose of this study was to investigate the potential for corn oil oleogels structured with three different concentrations of rice bran wax (RBW) (2%, 6%, and 10% w/w) to serve as a delivery system for curcumin to increase its bioaccessibility compared to an ungelled (0% RBW) control. Additionally, the physical properties of oleogels were characterized with and without curcumin to assess the impact of curcumin on oleogel physical properties. Various measures, including texture profile analysis (TPA), solid fat content (SFC), polarized light microscopy (PLM), differential scanning calorimetry (DSC), and x-ray diffraction (XRD) were used to characterize the oleogels. Moreover, an in vitro simulated digestion study was used to assess the bioaccessibility of curcumin in the oleogel systems. Data analysis revealed no significant differences in polymorphic or thermal properties between oleogels with and without curcumin; however, differences in microstructural properties were documented for oleogels with curcumin. No difference was observed in the SFC of ungelled and 2% RBW oleogel samples. Furthermore, oleogel hardness only differed at 10% RBW. After in vitro simulated digestion, oleogels prepared with 6% and 10% RBW significantly increased curcumin bioaccessibility relative to the ungelled control and 2% RBW oleogel. Results from this study provide insight into the potential utilization of RBW oleogels for delivering curcumin and other poorly water-soluble compounds in food, dietary supplement, pharmaceutical, and cosmetic industries.

Thursday, July 2, 2020
Session Time: 8:25 AM - 12:10 PM

Presentation Time: 9:20 AM - 9:45 AM

Track: Edible Applications Technology@@@Health and Nutrition

(3778) Sous Vide Cooking Changes Lipid Bioaccessibility of Egg Yolk

Presenting Author: April X. Xu - University of Guelph

Lipids are vital to human health; however, overconsumption of lipids, and the associated spikes of postprandial circulating free fatty acids, increases associated risk of chronic diet-related diseases such as diabetes, metabolic syndrome, and cardiovascular disease. Recent research has elucidated that lipid bioaccessibility is affected by the physical parameters of foods such as its viscosity, particle size, and matrix structure. The relationship between structural changes induced

by cooking and lipid bioaccessibility has not been well characterized. This research studies how heat-induced gelation of egg yolk affects lipid bioaccessibility. Structural changes in yolk are characterized using rheology, thermal analysis, Fourier-transform infrared spectroscopy, and imaging techniques such as confocal and light microscopy. Using the gold standard for in vitro gastrointestinal digestion – TIM-1, the effects of sous vide cooking temperature on three bioaccessibility parameters – total bioaccessibility, induction time, and rate of lipolysis, are compared. Preliminary results show significant differences in bioaccessibility parameters between temperature treatments. This research will provide insight on how food processing and even preparation may affect the kinetics of digestion and ultimately postprandial free fatty acid release.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology@@@Health and Nutrition

(3760) Microencapsulation of Chia seed oil in protein-polysaccharide matrix system: Characterization, oxidative stability and in vitro digestion

Presenting Author: Iqra Yasmin - NIFSAT

Chia seed oil is a rich source of polyunsaturated fatty acids, specially α-linolenic acid and its protection against oxidation is serious challenge. In this context microencapsulation by using suitable encapsulating material is one of the strategy to overcome this problem. The aim of the current study was to develop microparticles through spray drying technique by using protein-polysaccharide matrix system (lentil protein isolate, pectin, water chesnut mucilage as a wall materials). Emulsions were prepared and analyzed for their stability and viscosity. All emulsions showed good stability and no phase separation except whey protein isolate. The produced microcapsules were characterized on the basis of encapsulation efficiency, moisture content, particle size, morphology, color, surface oil, density, flowing properties, lipid oxidation and oxidative stability. The in vitro digestion of microparticles were also evaluated. Water chesnut mucilage and lentil protein isolate (1:1) showed highest encapsulation efficiency (90.23%) and SEM images revealed that the particles were smooth without visible cracks on surface. Morphological analysis of all microparticles revealed considerably small particle sizes. Furthermore, the combination of protein and polysaccharide provided an even more effective interfacial barrier than single wall material. In vitro gastrointestinal digestion results revealed that lentil protein isolate and pectin greatly retarded the oil release from 80.82% to 43.3%. The current study suggested that these encapsulation formulation has the potential to overcome oxidative stability issues, have effective targeted delivery and control release during digestion. These wall material could effectively use in food industry for encapsulation of different essential oils.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology@@@Health and Nutrition

(3891) In-vitro Digestion of Water-in-oil Emulsions Stabilized with Fat Crystals

Presenting Author: Jonathan Andrade, PhD - Ryerson University

The purpose of this research was to investigate the effect of emulsifier type and presence of solid fat on the stability and dye release characteristics of water-in-oil (W/O) emulsions subjected to simulated gastrointestinal conditions. Emulsions consisting of a 20 wt% aqueous phase dispersed in canola oil were stabilized in one of four different ways: core-shell stabilization with glycerol monostearate (GMS), network stabilization using polyglycerol polyricinoleate (PGPR) and solid fat added to the continuous phase (PGPR-F), combined core-shell and network stabilization using glycerol monooleate and a continuous phase fat crystal network (GMO-F) and finally, a PGPR-based liquid emulsion with no added fat. The dispersed aqueous phase of all emulsions contained 1 mM methylene blue (MB), which was used as a marker to quantify emulsion breakdown and release of aqueous phase cargo. When subjected to gastric conditions, the PGPR-F emulsion showed the lowest MB release after 60 min (< 3% of initial load) with the other emulsions showing ~ 12% release. In duodenal conditions, the PGPR-F and GMS emulsions showed the lowest MB release after 120 min of exposure (~5%) followed by the PGPR (9.4%) and GMO-F (14.6%) emulsions, respectively. Emulsion photomicrographs taken prior to, and after, contact with simulated gastric and intestinal fluids showed that emulsion microstructure was an important contributor to emulsion stability. Overall, the PGPR-F emulsion was the most stable in both gastric and intestinal fluids. These results have shown that fat phase structuring is key parameter to control W/O emulsion breakdown behaviour in simulated gastrointestinal conditions.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology@@@Health and Nutrition

(3681) Structuring Liquid Oils Through Enzymatic Glycerolysis

Presenting Author: Reed A. Nicholson - University of Guelph

Hydrogenation, interesterification, and fractionation are commonly used to improve the functionality of edible oils. However, these processes do so by altering crystallization behaviour through increases in saturated fat content. Palm oil, because of its solid structure, is also used in numerous food applications including margarine and shortening. In this research, enzymatic glycerolysis was used to convert native triacylglycerols into mono- and diacylglycerols of higher melting point to directly structure liquid oils without altering the fatty acid composition of the

system. Reactions were performed at 65°C for various time lengths in the presence of glycerol using Candida antarctica lipase B as the catalyst. Differential scanning calorimetry showed a 20°C increase in crystallization onset for several oils following glycerolysis. Pulsed nuclear magnetic resonance demonstrated that optimized reactions increased the solid fat content (SFC) at 5°C from 8% to 26% and 34%, for cottonseed and tigernut oil, respectively. At 20°C, 14% and 8% solids remained in the respective oils. Structured cottonseed and tigernut oils produced under optimal reaction conditions showed no oil loss following 1 h of centrifugation at 5°C. Both cottonseed and tigernut oil produced margarines demonstrating plastic flow behaviour similar to commercial margarines when subjected to large deformation mechanical testing. Furthermore, the SFC of peanut oil increased from 3% to 30% at 5°C and 10% remained at 20°C. This structured oil was effectively used to stabilize peanut butter. This research demonstrates that glycerolysis can be used to enhance the functionality of edible oils for use in food applications.

Monday, June 29, 2020

Session Time: 8:25 AM - 10:10 AM

Presentation Time: 9:20 AM - 9:20 AM

Track: Edible Applications Technology@@@Industrial Oil Products

(4110) Characterization of Biopolymer Films Incorporating Essential Oils Exhibiting Antilisterial Activity As Active-Packaging for Ready-to-Eat Foods

Presenting Author: Ran Tao - McGill University

Objective: With increasing emphasis on the use of biopolymers in food packaging, an active-packaging system based on incorporation of EOs in soy protein isolate (SPI) films was investigated for the purpose of inhibiting the growth of Listeria monocytogenes on ready-to-eat foods. **Methodology:** Oregano and cinnamon EOs and carvacrol shown high antimicrobial activity against L. monocytogenes were added to 5% SPI film-forming solutions at concentrations of 1-3% (w/v). Their effects on the characteristics of SPI films, including mechanical properties, water vapor permeability, opacity, and water solubility, were evaluated. In addition, Fourier transform infrared (FTIR) spectroscopic characterization of the films was employed to examine the effects of the EOs on protein secondary structure and to study the diffusion kinetics of the EOs. **Results:** The type of EO, the concentrations of glycerol and EO in the film-forming solution, and the emulsification treatment employed in preparing the films influenced their mechanical properties, water vapor permeabilities, and opacities. Films incorporating 2% of EO exhibited high antilisterial activities in vapor phase. FTIR spectroscopic characterization of the films indicated interactions between soy proteins and EOs resulted in some transformation of β-sheet to α-helical structure, consistent with a plasticizing effect of the EOs. The EO diffusion kinetics were well fit by a Weibull model, with a high correlation coefficient (>0.995) and low RMSE (<0.001). **Conclusion:** SPI films incorporating EOs exhibiting antilisterial activity have potential utility as active-packaging for ready-to-eat foods. Information on protein-EO interactions influencing film properties and release of active

compounds are provided by FTIR spectroscopy and can aid further development of active-packaging.

Wednesday, July 1, 2020
Session Time: 10:25 AM - 1:25 PM

Presentation Time: 1:00 PM - 1:00 PM

Track: Edible Applications Technology@@@Industrial Oil Products

(3804) Study on Macroscopic Properties, Microstructure and Aggregation Process of Monoglyceride and Vegetable Wax Based Oleofoams

Presenting Author: Zong Meng, Sr., PhD - Jiangnan University

Different concentrations of monoglyceride (MAG) and beeswax were employed to structure the whipped oleogel, respectively. The concentration influenced the growing and the distribution of crystals network. Oleofoam samples were characterized with microstructure, whipping time, foamability, air bubble size distribution, rheological behavior, thermodynamics, visible appearance, and the link between the macroscopic properties to the microstructure of samples. The shape of the air bubbles, crystals distribution in the continuous phase and adsorption layer at air-oil interface were closely related to the MAG and beeswax concentration. All the whipped oleogels had the similar high overrun, nevertheless, increasing concentration meant less whipping time under the same conditions. In contrast, oil foams prepared at high concentration improved foaming ability as well as foam stability. Oleofoams at all concentrations showed solid-like viscoelastic behavior as measured by the frequency sweep experiment, and them exhibited favorable thixotropic recovery at alternating high and low shear rates. Temperature sweep tests indicated that oil foams underwent a sol-gel transition when heating and cooling, and transition temperatures were increasing in turn. Furthermore, the evolution of microstructure of oleofoams provided a more intuitive understanding of the foaming process. It was clarified that partial coalescence was happened with further whipping when passed the endpoint. In addition, partial coalescence would cause a merger between air bubbles and led to the decrease of the foam overrun. This study gave more information on the application of the edible oleofoams.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology@@@Industrial Oil Products

(3601) Application of Palm Fractions to Increase Thermal Stability in Filling Chocolate Cake

Presenting Author: Maryam Gharachorloo - Islamic Azad University, Science and Research Branch

Physical instability and cohesion of fat-based filling in baking products have long been one of the major problems in the food industry. Since the continuous phase of these fillings is fat, the desired thermal stability can be achieved by selecting the appropriate oil. Palm oil and its products are oxidation resistant and stable for a long time at high temperatures. In this study, in order to achieve heat stable oil in the formulation of cake filling, palm oil was fractionated by solvent at 5 and 17°C. Then physicochemical tests such as fatty acid composition, solid fat content, thermal behavior analysis, melting point, saponification, iodine, peroxide and acid values were performed. Palm olein obtained from 17°C was used in the filling formulation and the effect of cooking temperature and storage time on the sensory, physical and rheological properties of the filling (hardness, cohesion, adhesion, gummy state) were evaluated. By reducing the temperature of fractionation the percentage of unsaturated fatty acids in stearin fractions decreased. The palm-olein obtained from 17°C was suitable for using in formulation of filling due to fast melting profiles and relatively high solids content in 20°C, and uses in formulation of filling has affected all texture factors. Temperature and time alone did not differ in the rheological, physical and sensory characteristics of the filling ($P > 0.05$), but at the same time caused a difference in the mentioned factors ($P \leq 0.05$). The palm olein obtained from 17 °C created a thermal stability in the cake filling formulation.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology@@@Industrial Oil Products

(3763) Thermo-mechanical behavior of different Ethylcellulose-Monoglycerides mixtures during the development of Organogels

Presenting Author: Jorge F. Toro-Vazquez, PhD - UASLP-FCQ

The ethylcellulose (EC) is a linear polysaccharide with the unique ability of gelling vegetable oils (VO). However, in the presence of a surfactant (e.g., monoglycerides, MG), the thermo-mechanical properties of the EC oleogels are modified. The aim of this research is to evaluate the thermo-mechanical behavior of EC (7, 8, and 10%) in VO in the presence of MG at concentrations below the gelling capacity of MG (0.1% to 1.0%). The results showed that in

contrast to the 10% EC system, the 7% and 8% EC did not gel the VO. However, in the presence of MG, the 7% and 8% EC developed well-structured gels, particularly as the MG concentration increased. The elasticity (G') behavior during cooling of EC-MG systems, and DSC and infrared results showed the presence of three major MG-EC interactions. At low EC (7%) and MG (0.1% to 0.5%) concentrations, the MG formed hydrogen bonds with free -OH groups of different EC chains, acting as a cross-linking agent and thus increasing the G' of the EC-MG gel. At 8% and 10% EC the MG (0.1% to 0.5%) acted as a plasticizer decreasing the gels' elasticity. At 1% MG, independent of the EC concentration, the excess of MG ("free") crystallized throughout the EC fiber network acting as active filler. The overall result was a dramatic increase in the EC-1% MG gels' elasticity, an effect more evident as the EC concentration increased. These results indicate that it is possible to engineer the EC oleogels' rheology modifying the EC to MG proportions.

Tuesday, June 30, 2020

Session Time: 11:40 AM - 12:35 PM

Presentation Time: 11:45 AM - 11:45 AM

Track: Edible Applications Technology@@@Phospholipid

(3691) Incorporation of Bigels into Yogurt to Improve Probiotics Survival

Presenting Author: Xiaoqing Zhuang - Iowa State University

The probiotic yogurt market is growing due to the potential benefits that probiotics provide to the host, including the relief of lactose intolerance symptoms, easing diarrhea, and improving immune system. However, probiotics are sensitive, both processing conditions and high acidity of yogurt can reduce probiotic viability. The objective of this study was to use bigel technology, a novel entrapment system, to improve the survival of probiotics incorporated into yogurt. Bigels were formulated by blending oleogel emulsion (OGE) and hydrogel (HG). In this study, probiotic bigels were prepared by homogenizing OGE (10% wt/wt soy lecithin, 10% wt/wt stearic acid, 10% wt/wt milk and soybean oil) and HG (25% wt/wt whey protein concentrate and deionized water) followed by incorporating Lactobacillus acidophilus and Bifidobacterium lactis suspended in milk. Four samples were prepared: yogurt with 18% wt/wt probiotic bigels with and without agitation, yogurt without probiotics and bigel, yogurt with only probiotics (no bigel). Probiotic viability at 4°C was monitored via plate counts for six weeks. The results showed the growth rate of L. acidophilus and B. lactis in bigel was higher and decreased slower than those not in the bigel matrix, which indicated probiotics can be efficiently entrapped in bigel systems and the presence of phospholipids enhanced probiotic viabilities in yogurt. No significant difference was found between agitated and non-agitated samples, which indicated the bigel structure did not affect the probiotic viabilities in yogurt. This approach shows a promising future for bigel applications in commercial yogurt production to improve the efficacy of probiotics.

Thursday, July 2, 2020
Session Time: 8:25 AM - 12:10 PM

Presentation Time: 11:45 AM - 11:45 AM

Track: Edible Applications Technology@@@Phospholipid

(3711) Characterization of Semi-solid Materials made with a Dairy Phospholipid Isolate

Presenting Author: Zachary Cooper, MS - Utah State University

A dairy phospholipid isolate (PLI) containing 54.9% phospholipid (PL) was mixed with soybean oil at three different concentrations of PL (15%, 30%, and 45%) to form a semi-solid material. Samples were crystallized at 25°C for 24 h and solid fat content (SFC), viscosity, crystal morphology, melting behavior, and oil loss (OL) were measured. The SFC showed a significant increase ($p<0.0001$) as PL concentration increased with the 45% PL sample obtaining a final SFC of 48.9±0.7%. The viscosity was measured using shear rates of 0.01, 0.1, and 1.0 1/s showing a significantly higher viscosity ($p<0.0001$) for the 45% PL (2.6x104 ±2.5x103 Pa*s; 2.6x103±3.5x102 Pa*s) sample compared to the other two concentrations(6.2x102±5.7x102 Pa*s; 1.3x102±1.2x102 Pa*s) at the lower shear rates (0.01;0.1 1/s) respectively, while at the high shear rate the 15% PL sample had a significantly lower viscosity (6.1±0.7 Pa*s; $p<0.05$) compared to the other two samples (254.2±62.9 Pa*s). Crystal morphology was not affected by concentration except for the presence of rectangular structures observed in the 15% and 30% PL samples. The 30% PL sample had significantly longer and fewer rectangular-like crystals ($p<0.05$) than the 15% sample. The 30% PL sample had significantly larger crystals ($p<0.001$) than the other two samples. A significant difference ($p<0.001$) between the melting enthalpies was observed with enthalpy values increasing with PL concentration. The OL showed a significant decrease ($p<0.05$) as the concentration of PL increased. These results show that semi-solid materials can be obtained by mixing dairy phospholipids with soybean oil.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology@@@Phospholipid

(4177) Functional surfactants from microalgae: galactolipid and phospholipid rich sources of omega-3 fatty acids

Presenting Author: Eneko Ganuza - Heliae Development LLC

Galactolipids and phospholipids are the fundamental building blocks of cell membrane layers. Phospholipids predominate in loosely packed systems (e.g. Golgi and endoplasmic reticulum membranes) while galactolipids predominate in densely packed multilamellar systems (e.g. photosynthetic membranes). Interestingly, nature maintains these compositional distributions across all different life forms (eukaryotic or prokaryotic), and different biosynthetic pathways have evolved to produce these same molecules. This consistent pattern may be explained by the

specific surfactant properties of each molecule, which are controlled by the hydrophilic headgroup. Phospholipids contain one charged electric dipole whereas non-ionic galactolipids have multiple small electric dipoles that create tighter, more stable membranes. Perhaps the same tight galactolipid cohesion, which is essential for photosynthetic function, has possible food biosurfactant applications that are complementary to phospholipid-based lecithins. For example, galactolipid layer emulsions uptake less water than phospholipid emulsions, allowing for the formation of emulsions with aggregates and multilayer stacking. The close packing and high surface activity of galactolipid emulsions restricts the penetration of digestive lipases, and therefore they can potentially regulate dietary lipid absorption. While galactolipids are the most abundant type of lipids in nature and a signature lipid for plant-based nutrition, their application in the food industry is very limited compared to that of phospholipid-based lecithins. Unfortunately, galactolipids are generally dispersed in plant materials, which makes large-scale recovery expensive, and therefore food applications of galactolipids are relatively unexplored. Here we present a new commercial source of phospholipid and galactolipid-rich extracts from the marine microalga Nannochloropsis. This microalga contains at least two-times more galactolipids (6 % dry wt.) than any other vegetable (including spinach) and is also rich in phospholipids (3 % dry wt.). In addition, the algal polar lipids contain around 50 % fatty acids as omega-3 eicosapentaenoic acid. We demonstrated that, following the ingestion of Nannochloropsis oil, human blood plasma levels of omega-3 fatty acids increased above the levels of the krill oil control. These results suggest that the structure of the lipid extracts rich in galactolipids may improve the bioavailability of the omega-3.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology@@@Phospholipid

(4194) Effects of Lecithin on Chocolate Functionality in the Molten and Solid States

Presenting Author: Dérick Rousseau - Ryerson University, Toronto,

Emulsifiers are ubiquitous in confectionery manufacturing. In chocolate processing, they are used to enhance the flow properties of molten chocolate and in the solid state, they may enhance fat crystal growth by crystallizing or organizing before the bulk fat, thereby templating crystallization or hinder growth by adsorbing to fat crystal surfaces and creating unfavourable environments for growth. To develop a deeper understanding of the structure-function relationship of emulsifiers in molten chocolate, the interactions of lecithin with sugar crystals suspended in purified canola oil, used a proxy for cocoa butter, were assessed. Atomic force microscopy (AFM) was used to measure attractive forces on the nanoscale between a sugar substrate and a sugar-functionalized AFM cantilever in an oil environment. There was a lecithin concentration-dependent force of adhesion between the sugar particles. This critical concentration was assumed to be when monolayer coverage of the sugar particle by emulsifier molecules occurred. The significance of these interactions on macroscopic phenomena such as

sedimentation and apparent viscosity was also assessed. Lecithin enhanced cocoa butter nucleation and growth events during isothermal crystallization, however, in the presence of sugar, it was no longer able to influence nucleation and growth, due to its likely adsorption to the surface of the sugar crystals or through surface effects of sugar. Lecithin also had minimal effects on the form IV-to-V transition and enthalpy. Any such effect was further muted by the presence of sugar. Overall, the results of this study demonstrated that lecithin expectedly impacts the properties of both molten and solid state chocolate. However, the role of dispersed particles such as sugar must be taken into consideration when establishing the structure-function properties of emulsifiers such as lecithin.

Monday, June 29, 2020

Session Time: 10:25 AM - 12:35 PM

Presentation Time: 10:55 AM - 11:20 AM

Track: Edible Applications Technology@@@Processing

(4093) Effects of Shearing and Composition on Lipids Porosity

Presenting Author: Brandon Howard - The Ohio State University

Pores have been shown to play a predominant role in the functionality of crystallized lipids, and a detailed characterization of their porosity is necessitated. In this study, the effects of cocoa butter (CB) and trilaurin (TL) crystallization processing at 2˚C/min cooling and shearing at 500 s^(-1) in the presence or absence of monostearate (5 % w/w) on porous structural properties were quantified. Samples were sheared using a couette-type laminar crystallizer (LS) and a standard paddle mixer (PS) and evaluated for their melting point, solid fat content (SFC), and crystal structure. Data showed no effects of processing on sample melting points. However, bigger crystals with lower SFC’s were shown in samples containing monostearate, except for CB containing monostearate processed with laminar shear. X-ray computerized tomography of the samples showed that both processing and composition have significant effects on their final porous structure. Random sheared networks using PS produced well dispersed and disjoint arrangements of pores with 3 to 14% porosity. Whereas LS samples contained 0.002 to 8% porosity whether disjoint or highly connected. These effects of processing on the sample's pore network did not remain consistent in the presence of monostearate. The results of this study demonstrate the dependency of pores within crystallized lipid networks on their composition and crystallization conditions which can aid in further elucidating their functional properties.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology@@@Processing

(3764) An Economic Evaluation of Mitigation Alternatives in significantly reducing Glycidyl Fatty Acid Esters (GEs) and 3-monochloropropane-1,2-dial esters (MCPDs) in Palm and Soybean oils

Presenting Author: Marc Koukoulas - Artisan Industries Inc.

Over the last several years, edible oil producers and industry experts, including equipment and technology providers, have been focused on identifying the most technically and economically suitable alternatives in the reduction of GEs and MCPDs in some refined vegetable oils and, particularly, Palm oil, which is reported to have higher levels of these process-generated contaminants due to its high initial diacylglycerol (DAG) content. This presentation will share the results of a "case study" comparing the economics of currently used mitigation methods to a "Novel Short Path Stripping Process (SPS)" used in the reduction of GEs and MCPDs from commercially available refined oils. Third party analytical results confirmed a significant reduction of GEs and MCPDs in the edible oils used in the study.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology@@@Processing

(3614) The Effect of Minor Components on the Crystallization Behavior and Microstructure of Cocoa Butter

Presenting Author: Jay W. Chen - University of Guelph

The body of cocoa butter research focuses mostly on the major component, triglycerides, but there is a gap in knowledge on how the minor components affect its properties. In this study, we refined cocoa butter by neutralization and bleaching, before adding various minor components back to examine their effects on bulk crystallization behavior and structure. This included monoglycerides (GMS, GMP, GMO), free fatty acids (stearic, palmitic, oleic), and phospholipids (DMPC, DPPE). Samples were characterized by DSC, XRD, and light microscopy. Avrami crystallization kinetics were characterized from measurements of SFC as a function of time. The refining process greatly impacted the crystallization rate. The neutralized and bleached samples had a significantly higher rate constant of crystallization than unrefined cocoa butter. Furthermore, the unrefined sample had a melting temperature and XRD pattern characteristic of Form VI, while the refined samples displayed properties of Form V, suggesting the minor components play a role in polymorphic transitions and stability. Of the samples with additives, phospholipids and the free fatty acids appeared to cause the greatest impacts. DMPC and DPPE

increased the Avrami index and decreased the Avrami crystallization half-life time compared to the bleached sample, and the free fatty acids reverted the melting temperature back to ranges characteristic of Form VI. Understanding the extent to which minor components affect cocoa butter may open new doors to how to refine and prepare chocolate most effectively.

Tuesday, June 30, 2020

Session Time: 8:25 AM - 11:45 AM

Presentation Time: 9:45 AM - 9:45 AM

Track: Edible Applications Technology@@@Protein and Co-Products

(3669) Development and characterization of novel bigels for edible applications

Presenting Author: Mark A. Bollom, MS - Iowa State University

Bigels are a new technology with great potential for applications like protection and delivery of bioactive components. Their success with drug delivery in the pharmaceutical industry suggests they may be able to deliver sensitive food compounds. The purpose of this study was to develop and characterize a novel, edible bigel system. The bigel was prepared by homogenizing an oleogel emulsion composed of soy lecithin, stearic acid, soybean oil, and water (two usage levels), and a hydrogel composed of whey protein concentrate (two usage levels) and water. Five ratios of oleogel emulsion:hydrogel were examined and characterization was conducted through small angle x-ray scattering, rheology, and fluorescence microscopy. With addition of the hydrogel component, the oleogel emulsion retained its basic structural characteristics, but lost higher order structuring. The bigels were found to have temperature-dependent G' values, but from 8 to 98°C the bigel's showed G'>G''. Fluorescence microscopy revealed a bi-continuous bigel at equal proportions of oleogel emulsion and hydrogel; nevertheless, when either of those phases increased, one became the dominant continuous phase. Hydrogel addition increased the LVR's length compared to the pure oleogel emulsion, suggesting an improvement of the gel's mechanical properties. G' was greatest at 10 wt% water and 15 wt% protein in the oleogel emulsion and hydrogel, respectively, suggesting a synergy between phases. At protein and water contents outside the aforementioned, the relationship between phases became antagonistic towards the bigel's mechanical properties. In conclusion, a novel edible bigel was successfully developed with optimal properties for application in foods.

Tuesday, June 30, 2020
Session Time: 8:25 AM - 11:45 AM

Presentation Time: 10:55 AM - 10:55 AM

Track: Edible Applications Technology@@@Protein and Co-Products

(3808) Use of Fractal Analysis to Characterize the Structure of Whey Protein Colloidal Gels

Presenting Author: Clifford Park - Ohio State University

Recently, our group developed Oleocolloid and hydro Oleocolloid systems formulated with whey protein and oleogels having notably different rheological and microstructural properties compared to regular oleogels. Further examination of the developed colloidal matrices and the connections between proteins and lipids are studied in this research. Effects of protein-lipid interactions on oleogel crystallization and polymorphic behavior of lipid crystals in the developed systems were studied using X-ray diffraction (XRD) and differential scanning calorimetry (DSC). Samples' XRD and DSC spectra confirmed the existence of an orthorhombic sub-cell structure of β′ lipid crystals in all systems. However, results from rheological and microstructural analyses suggested potential effects of protein-lipid interactions on the physical properties of the matrices. To characterize these interactions and their relationships with the systems' structure formation, scaling theories were used. Networks' fractal dimensions were measured (from confocal microscopy images) and calculated using rheological data and strong or weak-link regime theories. Comparison of fractal dimension from microscopy and rheology data showed Oleocolloid was in weak-link regime whereas hydro Oleocolloid did not fit in any of the regime. This could be due to protein solubility, denaturation, and its interactions with lipids that are influenced by the formulation and processing conditions. This is in agreement with our previous Raman and Infrared analysis that illustrates different chemical interactions between proteins and lipids in water vs. oil medium. Understanding the physical nature of Oleocolloid matrices is important for applications in various food products particularly rich in proteins and healthy fats.

Tuesday, June 30, 2020
Session Time: 11:40 AM - 12:35 PM

Presentation Time: 12:10 PM - 12:35 PM

Track: Edible Applications Technology@@@Protein and Co-Products

(3751) Conversion of pulse protein-based oleogels into oleofoams for improved bakery application

Presenting Author: Athira Mohanan - Noblegen Inc

Food hydrocolloids such as proteins and polysaccharides have recently become a novel tool for structure formation in liquid oil thereby creating oleogels. We have previously demonstrated that strong oleogels with high oil binding capacity, and improved rheological properties can be

prepared using freeze-dried foams stabilized with pea and faba bean protein and canola oil containing small amount of high melting monoglyceride (MAG) and candelilla wax (CW). However, due to the inability of the oleogels to hold structure and stabilize air during batter preparation, cakes prepared using the oleogels displayed high batter density and poor textural properties compared to a conventional batter or cake prepared with shortening. The present study explored the use of oleofoams obtained by whipping oleogels using a rotating beater kitchen mixer (30 minutes) for baking. Oleogels were prepared by adding canola oil with and without of MAG (0.5-3wt%) to freeze-dried pea and faba bean protein stabilized foams (pH7). Study showed that the presence of MAG was necessary for the stability of oleofoam. Oleogels consist of 3%MAG formed the most stable oleofoams with highest overrun (170%), foam stability (86% of the original volume retained after 1 month) and storage modulus. Air incorporation in the batter was increased due to oleofoam (batter specific gravity decreased by 10-15% when oleofoam was used). Textural properties of the cakes prepared with oleofoam also became comparable to that of shortening cakes. Analysis of batter and cake microstructure also revealed that oleofoams were better alternative to shortening than oleogels.

Thursday, July 2, 2020
Session Time: 8:25 AM - 12:10 PM

Presentation Time: 8:55 AM - 8:55 AM

Track: Edible Applications Technology@@@Protein and Co-Products

(3671) Bigel systems as means to protect probiotics during in vitro digestion

Presenting Author: Mark A. Bollom, MS - Iowa State University

A bigel is a semi-solid biphasic system where both the oleogel and hydrogel phases are structured. They have superior properties compared to mono-phase gels. Many studies have explored bigels for drug delivery; however, no studies have reported their use in foods to protect sensitive ingredients. In a previous work we successfully developed a novel bigel composed of a whey protein hydrogel and soy lecithin, stearic acid, and milk oleogel emulsion. The objective of this work was to successfully entrap Lactobacillus acidophilus and Bifidobacterium lactis in bigel matrices to enhance their viability during gastrointestinal digestion. The effect of physical structure and phospholipids on probiotic survival were tested through three different matrices. One with soy lecithin (phospholipid source) and stearic acid, one with just stearic acid (phospholipid-free), and one without any oleogelators (no structure). In vitro digestion tests were performed and probiotic counts over time were measured. Sample firmness was analyzed at 4 (refrigeration temperature) and 37°C (digestion temperature) to account for physical hardness differences. Finally, GC fatty acid analysis explored the extent of lipolysis during digestion. The results show that structured bigels successfully provided protection to probiotics during digestion. Compared to the control, the structured gels had ~50 and 5-10% greater probiotic survival at the end of gastric and intestinal phases, respectively. Lipolysis was actively occurring, and unstructured samples had about four-fold more free fatty acids than structured gels. It was

shown that our novel bigel systems can be used to protect probiotics from harsh digestive tract conditions.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology@@@Protein and Co-Products

(3748) Structuring liquid oil into viscoelastic gel using Pickering pea protein nanoparticles: opportunities and challenges

Presenting Author: Chi Diem Doan - University of Saskatchewan

We have previously developed pea protein nanoparticles (PPN) using solvent desolvation method and used it to create stable Pickering oil-in-water (O/W) emulsions. The objective of the present work was to explore the possibility of developing emulsion-templated Pickering oleogels. 50wt% O/W Pickering emulsions were prepared by mixing oil and aqueous phase containing PPN (5-10 mg/ml) at different pH using a high-pressure homogenizer. All emulsions, except the one prepared with 5 mg/ml PPN at pH 3, displayed high stability and strong elastic behavior. Gelation in PPN emulsion was attributed to aggregation of Pickering oil droplets and a network of excess PPN holding the droplets in the aqueous phase. At 5 mg/ml PPN, a weak particle network was formed, and the emulsion-gel strength was more dependent on droplet aggregation. In contrast, higher particle concentrations thickened the interfacial protein layers and strengthened the continuous phase particle network. Lyophilization was better than oven-drying in creating stronger oleogels with better rheology, higher oil binding capacity and lower lipid oxidation. The oleogels stabilized by 7.5 and 10 mg/ml PPN at pH 7 and 9 revealed about ten-times stronger gel strength and higher stability against alternating shear and gravitation forces than other samples due to smaller droplet sizes and stronger emulsion gel network. In comparison with emulsion-templated oleogels stabilized by other conventional methods, PPN oleogels demonstrated better recovery of gel strength at different shear rates and a higher oil binding capacity (87%). These findings provide important insights into alternative non-trans and less-saturated fat systems for future food applications.

Wednesday, July 1, 2020

Session Time: 10:25 AM - 1:25 PM

Presentation Time: 12:10 PM - 12:35 PM

Track: Edible Applications Technology@@@Surfactants and Detergents

(3798) Development of Emulsifiers from Pea Starches using Octenyl Succinic Anhydride Modification for the Beverage Emulsions

Presenting Author: Supratim Ghosh, PhD - University of Saskatchewan

In spite of growing commercial importance of pulse proteins, pulse starch, a major co-product of the pulse processing industry, shows limited industrial application. The objective of the study was to expand the utilization of pulse starch as an emulsifier by using octenyl succinic anhydride (OSA) modification. Pea starch (PS), along with commercial normal corn starch (NCS) and waxy corn starch (WCS), was modified with 1, 3 or 5wt% OSA. Structure, functional and emulsifying properties of OS-starches were characterized. All OS-starches showed lower pasting temperatures and higher peak viscosities compared with their corresponding controls. Canola oil (5wt%)-in-water emulsions were prepared with 2wt% OS-starches by high-pressure homogenization. The OS-PS dispersion decreased oil-water interfacial tension from 21.1 to 6.9-9.5 mN/m, similar to other modified starches. The droplet size of fresh emulsion stabilized by OS-PS was 160 nm, which increased considerably to 295 nm after storing at 4 °C for 28 days. In contrast, emulsion stabilized by OS-WCS exhibited better stability as the droplet size (154 nm) remained unchanged. The emulsions formed by OS-PS showed excellent stability under mild pH conditions (7.0 to 5.0) and heating at 90 °C for 30 min; however, they destabilized when the pH further dropped to the range 4.0 to 2.0 or when 0.1 M sodium chloride was present in the system. Overall, OS-PS showed the ability to create an emulsion with relatively small droplet size, but the emulsions were less stable against environmental change and long-term storage compared to emulsions formed by OS-WCS.

Friday, January 1, 2021

Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology@@@Surfactants and Detergents

(3683) Visual observations of mono/diglycerides, polysorbate 80, and milk proteins modulating coalescence between two fat globules

Presenting Author: Abbey E. Thiel - UW-Madison

It's well documented that many whipped, dairy emulsions undergo controlled fat destabilization during processing to produce partially-coalesced fat globule networks. To help control destabilization, many manufacturers formulate products to include one or several low-molecular weight surfactants. Frequently, formulations use mono/diglycerides and polysorbate 80 in

tandem as a source of emulsifiers. Additionally, many of these foods contain protein, which will also add to the amount of surface-active agents. To gain a better understanding of how each of these surfactants, alone and in tandem, can alter coalescence between two fat globules, micromanipulation methods were used. Oil-in-water emulsions were generated to contain the desired surfactants and transferred onto a microscope stage that contained two micromanipulators capable of moving individual fat globules. The amount of strain, or linear deformation, was recorded before and after two globules were brought into contact as a measure of coalescence. The time it took two globules to fully relax into their final structured was also documented along with real-time videos and micrographs. It was seen that when milk protein was the only emulsifier present, fat globules could be contacted, but no coalescence would be initiated. However, if protein was used with low-molecular weight surfactants like mono/diglycerides and polysorbate 80, the protein no longer protected the droplets from coalescing. Interestingly, different ratios of mono/diglycerides: polysorbate 80 didn't alter strain between two droplets but did greatly increase the time it took to coalesce. It's suggested that mono/diglycerides crystallizing at the fat-water interface is slowing coalescence.

Friday, January 1, 2021
Session Time: 1:00 AM - 2:00 AM

Presentation Time: 1:00 AM - 2:00 AM

Track: Edible Applications Technology@@@Surfactants and Detergents

(4111) Surfactant competition destabilizes particle-stabilized emulsions

Presenting Author: Malek El-Aooiti - Ryerson University

Particle-stabilized water-in-oil (W/O) emulsions are commonly sought for applications that demand long-term stability against emulsion breakdown. However, their remarkable stability may pose problems for applications that require controlled destabilization. Here, we investigate the controlled destabilization of W/O emulsion stabilized by a high-melting, crystalline surfactant, glycerol monostearate (GMS), used to kinetically stablilize model emulsions as a particulate surfactant. Controlled, reproducible emulsion destabilization is achieved using a liquid-state surfactant, sorbitan monooleate, which alters the wetting behaviour of the GMS crystals, but does not lead to their desorption from the interface. Rather, they transition from being oil-wet to water-wet, which reduces their ability to stabilize the starting oil-continuous emulsions. The measurements of interfacial tension, contact angle, emulsion stability and microscopy are used to support the proposed mechanism. An explanation of the observed behaviour leads to a better understanding of the stabilization and breakdown mechanisms of particle-stabilized emulsions.