Processing Interest Area
Technical Program Abstracts

Table of Contents

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PRO 1: Processing

Chairs: F. Skold, Solex Thermal Science Inc., Canada; and N. Suarez, Richardson Oilseed, Ltd., Canada

Enzyme Degumming is More Than More Oil. T.S. Hitchman[1], A. Sein[2], and W. Smits[2], [1]DSM, USA, [2]DSM, The Netherlands.

Enzymatic degumming is a known alternative to water degumming that addresses the yield-loss issue. Phospholipase C enzymes specifically react with the phospholipid impurities in oil, leaving the bulk oil untouched. Phospholipases break phospholipids into water-soluble and oil-soluble fragments, thereby reducing the ability to form an emulsion. Less emulsion means less yield loss due to entrained oil, and less gums, enabling cleaner separation of oil and heavy phases, with further reduction in yield loss.

For oil yield optimization of soybean oil, phospholipase C enzymes are preferred as they 1) it converts phospholipids into diglycerides and 2) it breaks the emulsifying capacity of the phospholipids, thereby minimizing the oil loss to the gums. Due to conversion of PC the reduction in entrained oil yield loss by degumming with phospholipase C is equivalent to the benefits obtained with PLA enzymes. The DAG produced by PLC enzyme degumming, however, is a bonus oil yield that doubles the yield benefit and is retained throughout the refining process. This talk will be focused on the next generation degumming solutions to enhance yield, regardless of level of phosphor or the proportion of non-hydratable phospholipids in the crude oil. Not the action of the enzymes itself but the application of them in the crushing, degumming and refining of oilseeds will be the focus of this lecture.

White Flake Desolventization, Reports from the Field. R.W. Ozer, Crown Iron Works Co., USA.

Soy White Flakes are used in a variety of products ranging from Soy Protein Isolate or Concentrate to the starting material for the manufacture of Texturized Vegetable Proteins. This paper will briefly discuss the applications for Soy White Flakes and overall markets.

While the technology for White Flake Desolventization has been well known for over 30 years, there are relatively few plants exploiting this technology worldwide. Several startups for White Flake Desolventization plants occurred in 2015 or are scheduled for early 2016. We will relate some of the experience gained during these startups and potential impact on Capital & Operating Costs.

New Developments on Refining Processing Technologies. M. Salazar Pena, P.M. Nielsen, H.M. Lilbaek, E.M. Meneguetti, M. Bollinger, and H.C. Holm*, Novozymes A/S, Denmark.

Recent developments on vegetable oil refining have focused on increasing the oil yield by optimizing the degumming part of the process, either enzymatically or by other means. This has proven to be efficient, but is that the end of the story? The truth is that processors are still struggling to get the most out of their process while maintaining a stable good product quality allowing them to actually sell or further transform their products. Concepts like miscella degumming, combined or simultaneous processes, more active enzymes, new improved bleaching earths, etc. have been around for years, but it is only until now they have demonstrated to be paving the way towards more robust and simplified processes, while at the same time enabling producers to have a better process economy. We will present true case stories and testimonials from customers and their experience on taking the advantages of applying new refining processing technologies.

New Concept in Shallow Bed Extractor. A.A. Demarco, Desmet Ballestra Group, Argentina.

Today in the Solvent Extraction, there are several extractor type. While the basic technologies used is similar, the different mechanical designs make important difference in between.

Is well known that some Oilseed Companies has preference for certain type of the extractors and the called “shallow bed” is one of those types.

Desmet Ballestra had designed, constructed and started up successfully in 2015 the first extractor with low layer material with unique features in the market. Modular, easy to transport, expandable, very simple among others are the features of this new extractor design called LLL (Low Layer Loop).

As well is very important to mention than easy maintenance, high performance, and safety are in the basis of the design.

Waste Heat Optimization in Soybean Processing. M. Abid, Solex Thermal Inc., Canada.

The conditioning of Soybean or canola is an important step in preparation for Extraction process. It is also an energy intensive process with waste heat recovery potential which can reduce the overall steam consumption of the Processing plant.

Innovative Plate technology provides solutions that allow for efficient heat transfer. Low-grade energy that is otherwise wasted or not economical to recover can be a source of cost savings by reduction in steam consumption. It is essential to utilize high heat area to enhance heat transfer efficiency when dealing with a low-grade heat from multiple sources: water, steam or condensate

The heat recovery loop can be optimized for maximum energy savings along with design that allows for a wide range of operational flexibility. It is critical for plant operators to understand and grasp the importance of an optimized heat recovery loop that maximises energy saving and pay back on capital investment. This paper covers fundamentals that are critical when designing a heat recovery loop in a crushing

plant.

Improving the Bottom Line of Oils and Fats Refining. K.F. Carlson, RBD Technologies, Inc., USA.

The presentation will identify certain issues that often are overlooked or ignored when refining oils and fats. This can mean higher processing losses and/or lower product quality and therefore increased operating costs. The topics will include examples and the potential financial consequences of the following:

Quality of raw materials: Cheaper can mean higher processing losses and lower product quality.
Laboratory: Insufficient evaluation of incoming raw materials and correlation to refining losses and product quality.

Production management: Frequent feed capacity changes and interruptions, unscheduled stoppages and insufficient storage facilities.

Processing conditions: Incorrect settings for process aids and operating parameters.

Operation: Over reliance on SCADA and/or insufficiently trained operating staff.

Modern Soft Seed Pressing Plant Design. H.C. Boeck, HF Press+LipidTech, Germany.

Apart from the basic technology, several additional aspects like logistics, accessibility, expandability, flexibility or ease of operation need to be considered when designing a modern soft seed pressing plant. This paper will recall the different processing steps and alternatives. It will also highlight the relevant factors influencing the design and with that the customer value.

Increased Efficiency in Enzymatic Degumming with a New Phospholipase. P.M. Nielsen, Novozymes A/S, Denmark.

The enzymatic degumming is well established in the oil industry. The majority of plants are using the phospholipase A enzyme for the reaction. Different types of enzymes are on the market all characterized by requiring reaction temperature of around 55°C, and pH in the water phase close to 5. The enzymatic degumming requires an acid treatment step followed by neutralization before the enzyme is added. Recently we have succeeded in developing a new type of phospholipase A1 which is able to operate at 70°C and without the addition of NaOH for neutralization. This means that it is not necessary to cool the oil for the enzyme reaction and NaOH addition is eliminated. The new heat stable enzyme is simplifying the degumming process and saves chemicals in the process. In this presentation we will document the properties of the heat stable enzyme and compare it to other enzymes used for enzymatic degumming.

PRO 2: Maintenance/Safety/Automation/Plant Training

Chairs: M. Vander Velde, Interstates Construction Services Inc., USA; and J. Glenski, Automation Plus, USA

Power Quality and Energy Management for the Process Industries. J.J. Boschuetz, Rockwell Automation, USA, Eaton Corp./Cutler Hammer, USA, University of Wisconsin, USA, Milwaukee School of Engineering, USA, Assn. of Energy Engineers, USA.

I. Power Quality & Energy Management (PQ&EM) Solutions for the Process Industries

A. Managing the Water/Air/Gas/Electric/Steam (WAGES) of your Process

B. Measuring/Monitoring/Reporting the "WAGES" Ingredients Which Make Up Your Process Costs

C. Justification for Investment to Better Manage your WAGES

D. Case Study (Excerpts) of PQ&EM Management in Process Industry

E. Tools to Help You (Freeware)

Desolventizer/Toaster Temperature Control Optimization Using Model Predictive Control. J. Vortherms, Interstates Control Systems, USA.

Abstract not available at time of posting.

Online Training Tools Through the Use of SharePoint: Microbial/Clean Design Standards Training. D.M. McCullough, Process Plus, LLC, USA.

The role of Engineers is to design out micro risk from equipment, facilities, utilities, and processes on which products are manufactured. It should be recognized that Engineers cannot eliminate all microbiological risk as the company may not always produce products in a sterile environment so the risk of microbiological growth is always present. The application of clean design requirements to equipment and facilities design can significantly reduce the risk of contamination during manufacturing. The intent of this document and accompanying training materials, risk tables, specifications, etc., is to provide a major consumer products company with the guidelines necessary to deliver microbial-free products. The impact is how to ensure a global organization has immediate access to this information.

It is through the use of the Sharepoint tool that this information was made available internally throughout the organization concurrently. Topics of the presentation will include the following:

- "What companies are doing now for training": Use of the SharePoint tool as a repository of training materials
- "Do's & Don'ts" for microbial free equipment and facility designs
- Use of risk tables: Understand your process; what to share and not share with OEP (vendor) equipment providers
- Virtual on-line testing & certification

Get Insight to Numerous Site Concerns with Pervasive Sensing. G.J. Hall, Emerson Process Management–Rosemount Measurement, USA.

There are many common challenges that sites face on a regular basis, with the most common being how do we address these challenges economically. Improving plant reliability, decreasing energy consumption, evolving process practices, complying with environmental regulations, and continuously improving plant safety are all topic being addressed with Pervasive Sensing.

PRO 3: By-products

Chairs: A.A. Demarco, Desmet Ballestra Group, Argentina; and S.R. Lewis, Solenis, USA

Extraction, Properties, and Applications of Cruciferin and Napin from Canola Meal. F. Pudel[1], R.P. Tressel[1], and K. Düring[2], [1]Pilot Pflanzenöltechnologie Magdeburg e.V., Germany, [2]Axara Consulting, Germany.

Canola proteins - which make up about 20 to 25% of dry seed weight – possess high nutritional value as well as promising functional properties. In comparison to other oilseeds canola contains two major fractions of storage proteins with completely different properties, the 2S albumin napin with a molar weight of 12-17kDa and the 12S globulin cruciferin with a molar weight of about 300kDa. A new technology to produce pure canola proteins, consisting of gentle oilseed processing, aqueous protein extraction, precipitation of cruciferin and expanded bed adsorption ion exchange chromatography for isolation of pure napin (or a new protein mix) will be presented. The new technology was developed in laboratory and up-scaled into small pilot scale. It allows to produce napin with a purity >98%, cruciferin with a purity >95% and, if desired, a new protein mix of about 56-57% napin and 43- 44% cruciferin. Protein separation is reproducible and can be scaled-up. The resulting protein products possess interesting functional properties enabling a wide range of possible uses both in food and non food applications (cosmetics, biochemistry, pharmaceutical). Particularly, napin is comparable or even better than egg albumin and could therefore replace animal albumins, e.g. in vegan foods.

Biological Salmonellicide. L. Palacios, Molinos Rio de la Plata SA, Argentina.

A biological salmonellicide base on a pool of fermented bacteria, all with GRAS (Generally Recognized As Safe) status, eliminates salmonella colonies in soybean meal three days after the application and protects the meal against new potential recontaminations for up to 180 days.

The product has been sprayed on more than 10 million metric ton of soybean meal since 2012, in a 20.000MT/day crushing plant, giving to 100% of the meal treated a salmonella free status.

The product is a very safe and environmental friendly solution for salmonella elimination and could replace with important advantages the chemical biocides, that reduce colonies concentration but do not eliminate the salmonella contamination.

Enzymatic Gums Deoiling: A Flexible Process for Increasing Oil Yield. W. De Greyt[1] and A.A. Demarco*[2], [1]Desmet Ballestra Group, Belgium, [2]Desmet Ballestra, Group, Argentina.

Alternative Enzymatic method, to make added value to a by product stream in the Crushing industry, is given here the basics of a process to optimize the performance of the oilseed crushing plant.

Deep Extraction and Enzymatic Degumming. L. Palacios, Molinos Rio de la Plata, Argentina.

The last developments in enzymatic degumming allow to get up to 2,5% extra yield converting most of the Phospholipids into DAG, reducing the amount of final gums, its oil content and the dilution of protein in meals.

With this technology available does make sense to extract as much oil as possible from the meal designing the extraction plant to reach 0,1% of residual oil content instead of 0,5/0,7 as it is usual.

The extraction plant will have a differential income of 5Kg oil /ton.

Regardless of the extraction plant capacity the incremental investment in the double washing time extractor will pay back during the first year of operation.

Dynamic Composition of the Alga Nannochloropsis sp. at Five Geographical Location Sites, with an Emphasis on High-value Omega-3 Fatty Acids as Co-products in a Biofuels Production Process. L.M.L. Laurens[1], E.P. Knoshaug[1], T.A. Dempster[2], P.T. Pienkos[1], and J. McGowen[2], [1]National Renewable Energy Lab., USA, [2]Arizona State University, USA.

One of the major challenges associated with algal biofuels production in a biorefinery-type setting is improving biomass production and utilization yields for high-value product isolation, with the aim of improving the techno-economical and life-cycle analysis outcomes. The ATP3 network of testbed sites across the United States provides a framework for harmonized physiological cultivation studies. We describe here the outcome of a year-long five testbed site cultivation experiment, presenting data on the dynamic composition of Nannochloropsis biomass and oils with a focus on high-value components such as omega-3 fatty acids associated with productivity trials at each of the 5 testbed sites. This is the first demonstration of an integration of productivity, physiological, geographical and meteorological data with composition and accumulation of high-value co-products. We found that the omega-3 fatty acid content of algal oils is influenced by physiological and geographical location and optimization of the composition of algae with respect to co-products can provide an avenue of improving the economics of a biofuels production process.

Antioxidant Activity and Chemical Composition of Extracts from Different Processed Rapeseed Waste Gums. J. Li and Z. Guo, Aarhus University, Denmark.

Valuable phenolic antioxidants were found in oil refining byproducts including soap stock, spent bleaching clay, wash water, and deodorizer distillate. However, no such works have been focused on waste gum. In the present work,

several techniques, namely ^{1}H-NMR, UV/Vis spectra, and HPLC, were used to confirm the existence of phenolics in waste gum. Thereafter, the phenolics and antioxidants were investigated in different fractions resulted from different processes including hexane refining and deoiling. The results indicated that the main phenolics were sinapic acid and canolol. Deoiling process by acetone extracted a large quantity of sinapic acid derivatives. Various antioxidant abilities, DPPH scavenging activity, Fe^{2+} chelating activity, hydroxyl radical scavenging activity, and reducing power, were measured. All extracts showed strong antioxidant activity. This study confirmed the value addition potential of phenolics and associated phospholipids in the waste gums. The resultant extracts may be a promising antioxidative emulsifier for food industry.

PRO 4: New Products Technology

Chairs: S.R. Gregory, DSM Food Specialties, USA; and W. Younggreen, Alfa Laval Inc., USA

Extraction, Properties, and Applications of Cruciferin and Future Directions in Oilseed Processing. C.L.G. Dayton, Bunge COE, USA.

This presentation will review purification methods for fats and oils based on the chemistry of contaminates. Focus will be on the major contaminates of Free Fatty Acids (FFA) and gums, comparing traditional acid, and base treatments with the cavitation technology and the various enzymatic processes.

A Process Roadmap to Implement Enzyme Degumming. S.R. Gregory[1], T.S. Hitchman[1], and W. Smits[2], [1]DSM, USA, [2]DSM, The Netherlands.

Oilseed processing plants are highly integrated operations where several product streams are generated from a single oilseed feedstock. As a result, making a change to the process parameters on one product line can have major operational and economic impacts throughout the plant. Understanding and managing these consequences is a critical part of deciding to change how the plant runs. Enzymatic degumming with Purifine is a unique process that results in increased yield of degummed oil by reducing heavy phase oil losses and release of the DAG component of the gums. The value of implementing Purifine degumming is further enhanced by integration into downstream refining and improvements in quality of co-products such as meal.

Not the action of the enzymes itself but the application of them in the crushing, degumming and refining of oilseeds will be the focus of this lecture. Purifine is the preferred industry standard used by numerous plants around the world, dealing with various processes and serving different markets (edible oil, biodiesel, crude degummed oils). In this lecture, we will present a roadmap for successful implementation to generate maximum value with processing assets. This map will zoom into the different parts of the process and highlight best practices and common mistakes in the industry.

Enzyme Degumming Startup Experiences—A Plant Perspective. F. Pifer, Perdue Agribusiness, USA.

Start-up experience with Enzymatic Degumming. Challenges as well as unexpected benefits. Partners in system development and operational control.

New Developments in Centrifugation. R.S. Zeldenrust, GEA Westfalia Separator Group GmbH, Germany.

Abstract not available at time of posting.

Centrifuge Settings and Operation for New Technologies. W. Younggreen, Alfa Laval Inc., USA.

Abstract not available at time of posting.

Cavitation Technology in Oilseed Processing. J.E. Willits, Desmet Ballestra North America, USA.

Cavitation can be of different origins, for instance: acoustic (usually, ultrasound-induced), hydrodynamic, generated with laser light, rotor stator, accelerated particles, an electrical discharge or steam injection.
The important characteristics of applied cavitation are the number of cavitation events in a flow unit, and the surface tension and the size of bubbles, which range from ten nanometers to a few microns or even larger in diameter.

- 29 Stages of flow through hydrodynamic Cavitation
- Complex geometrical configurations. Such as venturi, orifice plates, sonic vibrators, jet streams, turbulence zones, vortex chambers, high and low pressure zones.
- Can be configured from minor cavitation to super critical cavitation efficiency.
- Cavitation number (Cv) calculated for cavitation intensity. The Cv number at which the inception of cavitation occurs is known as the cavitation inception number (Cvi).
- Ideally, cavitation inception occurs at Cvi=1 and there are significant effects at Cv less than 1.
- On the velocity contour 1, below cavitation inception numbers shown in some areas of Cti's 7 stages reactor.

PRO 5: General Processing

Chairs: M.S. Alam, Texas A&M University, USA; and R.C. Clough, Texas A&M University, USA

Extraction of Omega-3-rich Oil from *Camelina sativa* Seed Using Ethanol-modified Supercritical Carbon Dioxide. H.D. Belayneh[1], R.L. Wehling[1], E. Cahoon[2], and O.N. Ciftci[1], [1]Dept. of Food Science & Technology, University of Nebraska-Lincoln, USA, [2]Center for Plant Science Innovation & Dept. of Biochemistry, University of Nebraska-Lincoln, USA.

Camelina sativa is a potential oil source for omega-3 and minor lipid components such as tocopherols and phytosterols. Conventional extraction of omega-3 oils is a concern; therefore, supercritical carbon dioxide (SC-CO_2) extraction is a green method to replace petroleum-based solvent extractions. The main objective of this study was to increase the oxidative stability of the camelina seed oil by increasing the content of antioxidant minor lipid components in the extract using ethanol-modified SC-CO_2. Camelina seed oil was extracted with SC-CO_2 and ethanol-modified SC-CO_2 (2.5%, 5% and 10wt%) at 35 and 45MPa pressure, and 50 and 70°C temperature. Adding ethanol as co-solvent increased the oil yield significantly at all pressures and temperatures studied ($P<0.05$). The highest oil yield (38.5wt%) was obtained with 70°C/45MPa/5wt% ethanol. No significant difference was observed in the total tocopherol and phytosterol contents under all extraction conditions ($P>0.05$). However, oxidative stability of the oils extracted with SC-CO_2 and ethanol-modified SC-CO_2 was higher than the oils extracted with expeller press and hexane. Solubility of camelina seed oil in SC-CO_2 studied with Chrastil model ranged from 0.0057kg oil/kg CO_2 at 35MPa/50°C to 0.0119kg oil/kg CO_2 at 45 MPa/70°C.

Processing of New Oil and Protein Sources: Zooplankton, Black Soldier Flies, and Grasshoppers. F. Pudel, G. Fleck, T. Piofczyk, and C. Spangenberg, Pilot Pflanzenöltechnologie Magdeburg e.V., Germany.

Zooplankton, e.g. copepods or artemia, can be grown by use of vinasse as feedstock, a by-product of the bio-ethanol production. Black soldier fly (*Hermetia illucens*) larvae fed with bio-wastes increase their body weight within 14 days by the factor of 40. Grasshoppers (*Locusta migratoria, Schistocerca gregaria*) develop from egg to matured insect also within about two weeks using green fodder. All these species are rich in oil and protein and represent therefore an interesting new source for animal or human nutrition as well as non food applications. The presentation will describe growing and processing technologies of these species, will give new information about their composition and will show possible applications.

Formation of Hollow Solid Lipid Micro- and Nanospheres to Develop Bioactive Carriers Using a Simple and Green Method. J. Yang and O.N. Ciftci, University of Nebraska-Lincoln, USA.

The main objective was to form hollow solid lipid micro- and nanospheres from fully hydrogenated soybean oil (FHSO) using a simple and green method based on atomization of the CO_2-expanded lipid to develop bioactive carriers. Hollow spheres ($d_{50\%}$= 278nm) were obtained using 50µm nozzle diameter at 200bar. The process allowed us to change the shell thickness of the hollow spheres by controlling the pressure. Polymorphism of the lipid spheres was changed from β to α by decreasing the nozzle diameter. Melting point of FHSO decreased from 69°C to 57°C above 120bar in CO_2, and onset melting temperature of the hollow lipid spheres was 50°C due to nanosize and α form. Essential oil was loaded into the spheres in a single step during particle formation with loading efficiencies up to 74wt%. Essential oil-loaded nanospheres (d_{mean}= 173nm, polydispersity index (PDI)=0.3) were successfully added into water and formed clear liquids. The process is simple and green, can be easily scaled up to develop health and wellness promoting functional food ingredients. Hollow structure provides high loading capacity, solid shell protects sensitive bioactives, and nanosize make it possible to prepare beverages using water insoluble bioactives.

High Quality Lard with Low Cholesterol Content Produced by Aqueous Enzymatic Extraction and β-cyclodextrin Treatment. Y.F. Liu, J. Jiang, Q.L. Wang, and P.R. Cao, School of Food Science & Technology, Jiangnan University, China.

In this study, a novel application was developed to extract lard from pig fatback, a by-product of the slaughter plant, by an aqueous enzymatic extraction method (AEE). Various proteases with different properties including Alcalase 2.4L, Neutrase 1.5MG, Flavourzyme 1000L, and Protamex were evaluated for their efficiency in oil release and lard qualities. Alcalase 2.4L was more effective for oil extraction with a yield of 95.19%. A high quality of lard was produced by AEE in comparison with lards produced by conventional extraction methods in aspects of color, acid value, peroxide value, phospholipids, cholesterol, and oxidation stability. A further refinement to reduce cholesterol from lard by b-cyclodextrin (b-CD) was developed and the optimal conditions were established. The optimal conditions were 7% b-CD addition (w/w) to a mixture of equal amount of lard and distilled water at reaction temperature 50°C for 60min. The cholesterol content of lard from refinement process was about 3.2mg/100g which was about 93.7%

reduction from 51.2mg/100g. Factors that were components of lard or produced during the lard extraction processes were evaluated for their influence on the cholesterol removal. Phospholipids could slightly enhance cholesterol removal, while free fatty acids would have inhibitory effects because of their competition with cholesterol for b-CD.

Oilseeds Continuous Pressing: Theoretical and Experimental Analyses. L. Bogaert[1,2], H. Mhemdi[1], P. Carre[2], F. Fine[3], A. Quinsac[3], and E. Vorobiev[1], [1]UTC/ESCOM, France, [2]CREOL, France, [3]TERRES INOVIA, France.

Continuous screw pressing is widely used for mechanical extraction of oil from oilseeds. Despite significant recent advances in the field of press design and automation, it remains difficult to predict performance based on theoretical approaches. This work is devoted to better understand, characterize and model the solid/liquid behavior in a screw press by comparing experimental and theoretical approaches.

For this purpose, a pilot (0-40kg/h) screw press (REINARTZ, Germany) was instrumented and divided into 5 sections. Winter rapeseed seeds were used for investigation. For each section, the pressure, the temperature and the oil flow rate were measured and recorded. Additionally, press cakes were sampled in the different sections and analyzed (porosity, residual oil content).

The experimental results showed the presence of successive sections of compression and mixing. An agreement was found between oil flow rates and pressure values in the compression sections. The total oil yield increased with lower rotation speed and the maximal oil yield was approximately 90%. The residence time distribution in the press was studied and showed an important oil recirculation and axial dispersion of mass flow through the screw press. These phenomena will be taken into account for oil expression kinetics modeling.

Concentration of Stearidonic Acid from *Echium* Oil by Urea Complexation. L. Vázquez[1], E. Ortego[1], M. Corzo-Martínez[1], G. Reglero[1,2], and C.F. Torres[1], [1]Dept. de Producción y Caracterización de Nuevos Alimentos, Inst. de Investigación en Ciencias de la Alimentación (CSIC–UAM), Universidad Autónoma de Madrid, Spain, [2]IMDEA-Food Inst., CEI (UAM-CSIC), Spain.

Concentration of fatty acids ethyl esters (FAEE) polyunsaturated ω-3, particularly stearidonic acid (SDA, 18:4 ω-3), by urea complexation from Echium oil was studied. The variables involved in the process were investigated, such as urea amount and size (granulated or powder), dissolvent volumes and ratios (hexane/ethanol), FAEE amount and reaction time of the formation of complexes urea-FAEE. Concentration (%) of SDA in the final product and yield of the process were optimized. Similar behaviors were observed in urea complexation between FAEE α-linolenic (ALA)-linoleic (LA), and γ-linolenic (GLA)-stearidonic (SDA), attributed to similarities on their spatial chemical structures. In the laboratory, the optimal conditions were 3g urea (powder), 3.6mL of hexane, 0.54mL of ethanol and 800mg of FAEE, during 20 hours at 25°C. Then, a scaling pilot plant was carried out twice, obtaining more than 100g of final product, with a concentration of ~29% SDA and yield ~78%. Also, the analysis of ethyl carbamates (urethanes) did not detect these compounds in the final product. So it was obtained a mixture of FAEE with about 85% of bioactive fatty acids with anti-inflammatory properties, which it is considered a high added-value product with great potential for the synthesis of functional lipids and nutraceuticals.

Drying Oilseed Meals: Which is the Best Approach?
A.A. Demarco, Desmet Ballestra Group, Argentina.

Today energy and pollution have a strong role in the Crushing Oils seed Industry.

The oilseed meal drying has a big impact in the OPEX in the Crushing.

There are several equipment option for meal drying. This presentation bring a fair analysis/comparison in between the more typical meal dryers type.

The conclusion is useful to make a good decision for the next meal drying project in your plant.

PRO-P: Processing Poster Session

Chair: N.T. Dunford, Oklahoma State University, USA

1. **Theoretical Optimization of Vitamin E Recovery by Adsorption/Desorption Using Ion-exchange Resin.** K. Hiromori, K. Kanuma, N. Shibasaki-Kitakawa, and T. Yonemoto, Dept. of Chemical Engineering, Tohoku University, Japan.

We proposed a novel method for recovery of vitamin E (V_EH) by adsorption/desorption using strongly basic anion-exchange resin. V_EH was selectively adsorbed on the resin from deodorizer distillates of vegetable oils and completely recovered without thermal decomposition. However, only free fatty acid (FFA) was competitively adsorbed on the resin in the adsorption process and it was also recovered as an impurity in the V_EH rich fraction of the desorption process. Therefore, the adsorption conditions should be optimized to maximize the V_EH amount.

In this study, a mathematical model quantitatively describing the competitive adsorption of V_EH and FFA is constructed to determine the optimum conditions. The model takes into account mass transfer of each component from bulk liquid to the resin and adsorption by ion-exchange reaction on the resin in the batch system. The model constants are estimated by fitting with the batch experiments under various conditions. The model is extended by adding mass transfer along axis of the column packed with the resin. Using the estimated values of constants, the model well simulates the adsorption behaviour and determines the optimum feed volume to giving the maximum V_EH amount.

2. **Effects of Process Parameters on Levels of Fatty Acid Esters of 3-Chloropropane-1,2-diol (3-MCPD) and Glycidol (G) in Palm Olein.** V.R.R. Yettella and B. Eapen, AAK, USA.

Fatty acid esters of 3-Chloropropane-1,2-diol (3-MCPD) and Glycidol (G) are potentially carcinogenic contaminants commonly found in refined vegetable oils including palm olein. These contaminants are generated mainly through high temperatures during deodorization process in edible oil production. In this experiment, the influence of deodorization temperatures (185^{o}C – 255^{o}C) and bleaching with three natural clays in mitigating 3-MCPD and G esters in palm olein was studied. The results revealed that both bleaching with neutral clay and deodorization at low temperature was required to attain a balance between contaminants mitigation and preventing them from further creation during processing. Bleaching helped in reducing G esters levels. It was also observed that deodorization at low temperature helped in removing G esters and also in mitigating further increase in 3-MCPD levels.

6. **Application of Deep Eutectic Solvent for the Treatment of Free Fatty Acid: A Review.** A. Hayyan[1,2], C.W. Keat[1], S.N. Rashid[1,2], M.A. Hashim[1,2], M. Hayyan[2,3], and M.E.S. Mirghani[4], [1]Dept. of Chemical Engineering, University of Malaya, Malaysia, [2]University of Malaya Centre for Ionic Liquids (UMCiL), University of Malaya, Malaysia, [3]Dept. of Civil Engineering, University of Malaya, Malaysia, [4]Dept. of Biotechnology Engineering, International Inst. for Halal Research & Training (INHART), International Islamic University Malaysia, Malaysia.

Deep eutectic solvent (DES), has recently gained more interests from researchers as it has the potential to be substitutes for ionic liquids (ILs). Advantages of DES over ILs included simplicity of synthesis, lower production cost, negligible toxicity profile and sustainability with respect to environment aspect. DES is mixture of salt and hydrogen bond donor (HBD) and they have been used in industrial applications of processing and separation. However, There exist few sources of HBD and could be mixed with different salts such as phosphonium and ammonium salts to prepare DES. Generally, DESs have high thermal stability and low vapour pressure and relatively have low toxicity and biodegradability compared ILs. Recently, DESs were applied in the treatment of free fatty acid of different acidic raw materials for biodiesel production. Therefore this review aims to discuss the application of DESs in biodiesel industry and specifically in the treatment of free fatty acid for biodiesel production.

7. **Esterification of Free Fatty Acid in Acidic Crude Palm Oil Using (1S)-(+)-10-Camphorsulfonic Acid.** A. Hayyan[1,2], M.A. Hashim[1,2], M.E.S. Mirghani[3], M. Hayyan[2,4], and S.N. Rashid[1,2], [1]Dept. of Chemical Engineering, University of Malaya, Malaysia, [2]University of Malaya Centre for Ionic Liquids (UMCiL), University of Malaya, Malaysia, [3]Dept. of Biotechnology Engineering, International Inst. for Halal Research & Training (INHART), International Islamic University Malaysia, Malaysia, [4]Dept. of Civil Engineering, University of Malaya, Malaysia.

In this study, (1S)-(+)-10-camphorsulfonic acid was used for esterification of free fatty acid (FFA) of acidic crude palm oil (ACPO). The FFA of ACPO was 9% and (1S)-(+)-10-camphorsulfonic acid reduced the FFA to the minimum acceptable level (<2%) under optimum conditions. The effects of different operating conditions such as catalyst dosage, reaction time, molar ratio, and reaction temperature were optimized. (1S)-(+)-10-camphorsulfonic acid was recycled four times with acceptable activity. The produced biodiesel after the alkaline transesterification met the EN-14214 international biodiesel standard specifications.

8. **Extraction of Sesame Oil from Defatted Sesame Meal Using Supercritical Carbon Dioxide.** K. Kim[1,2], N.K. Choi[1,2], H. Kim[1,2], and I.H. Kim[1,2], [1]Dept. of Food & Nutrition, Korea University, Republic of Korea, [2]Dept. of Public Health Science, Graduate School, Korea University, Republic of Korea.

The extraction of sesame oil from defatted sesame meal was carried out by using supercritical carbon dioxide. Effects of temperature (40-70°C) and pressure (27.6-48.3MPa) on fractional extraction of sesame oil were investigated. Total content as well as composition of homologues of lignan and tocopherol in sesame oils obtained by fractionation were also examined. The highest extraction rate of sesame oil was obtained at 60°C and 48.3MPa. Most lignan in defatted sesame were extracted in the early extraction process. Detected tocopherol homologues were ?-T and d-T, respectively. Tocopherol was extracted in the early process as lignan. The highest total lignan concentration was observed in sesame oil obtained at 48.3 MPa and 60°C, while the highest tocopherol concentration was observed at 48.3MPa and 40°C.

9. **Clarification of Wheat-based Distillers' Solubles and Thin Stillage.** K. Ratanapariyanuch[1], Y.Y. Shim[2], S. Emami[2], and M.J.T. Reaney[2,3], [1]Dept. of Food & Bioproduct Sciences, University of Saskatchewan, Canada, [2]Dept. of Plant Sciences, University of Saskatchewan, Canada, [3]Guangdong Saskatchewan Oilseed (GUSTO) Joint Lab., Dept. of Food Science & Engineering, Jinan University, China.

Wheat-based thin stillage (W-TS) and wheat-based distillers' solubles (W-DS) are by-products from ethanol industry. W-TS and W-DS are potential commercial sources of acetic acid, 1,3-propanediol, and glycerolphosphorylcholine. Clarification is an essential early step prior to compound recovery. Five clarification strategies were studied including clarification agents, size-exclusion medium, fermentation coagulation, centrifugation, and ultrafiltration. Bentonite (0.4%, w/v) was the most effective clarifying agent for diluted W-DS. Wheat-based distillers' wet grains was used as compressible elastic size-exclusion medium to exclude solution particles. Solutions obtained by pressing the spongy solids had lower turbidity than W-TS. Fermentative coagulation employed endemic W-TS fermentation organisms that produced CO_2 and exopolysaccharides. W-TS particles aggregated, adhered to CO_2 gas bubbles, and floated as fermentation progressed. Centrifugation and ultrafiltration did little to clarification and were not investigated further. Fermentative coagulation reduced solution turbidity more effectively than other clarification treatments. In addition, fermentation generated separable protein-rich (50%, db) slurries rich in glutamic acid but low in lysine, tryptophan, and sulfur containing amino acids. Tryptic fragments of slurry proteins indicated that *Lactobacillus sp.* contributed major proteins of 39 and 50kDa.

11. **Life Cycle Assessment for the Production and Use of Palm Biodiesel.** C.W. Puah and Y.M. Choo, Malaysian Palm Oil Board, Malaysia.

The increase in energy demand worldwide and diminishing fossil fuel reserves have driven the development of sustainable alternative energy sources. To date, the most widely used renewable energy for transport and industrial sectors is the first generation biofuel. Fatty acid methyl esters, commonly known as biodiesel, derived from oils and fats have long been known as a potential diesel substitute. Biodiesel is suitable to be used neat or blended with petroleum diesel in any proportion in an unmodified diesel engine. However, concerns related to the emissions from the production and use of biodiesel has been discussed globally. Thus, this life cycle assessment study was conducted to investigate the environmental impacts from the production and use of palm biodiesel produced using palm biodiesel production technology developed by the Malaysian Palm Oil Board (MPOB). The results show that the environmental impact from the production of palm biodiesel is related to the use of methanol, while the use of palm biodiesel contributes to the impact categories of respiratory inorganics and acidification/eutrophication. In spite of these, the production and use of palm biodiesel is more environmental friendly as compared to petroleum diesel.

12. **Solubility of Tocopherol and Tocotrienols from Palm Oil in Supercritical Carbon Dioxide.** C.W. Puah and Y.M. Choo, Malaysian Palm Oil Board, Malaysia.

Crude palm oil (CPO) is unique among the common vegetable oils because it provides a good source of tocols (tocopherol and tocotrienols). Recognised as potent antioxidants, tocotrienols play a role in cholesterol lowering, tumour suppression, reversal of arteriosclerosis, and protection of the heart against oxidative stress. Taking into account the importance of tocols, particularly tocotrienols, this study was carried out to determine the solubility of tocols in supercritical carbon dioxide. The solubility data is important for the design and optimisation of the supercritical fluid extraction (SFE) of tocols from CPO. The SFE was carried out in a dynamic (flow through) system. The experiments were carried out in a 3 X 3 factorial design with three equally spaced pressures (14, 22 and 30MPa) and three equally spaced temperatures (40°C, 60°C and 80°C). The tocols fraction obtained were quantified using high performance liquid chromatography with fluorescent detection. The results showed that tocols have solubility in the range of 0.94×10^{-3} to 0.018mg/g CO_2 for the conditions investigated. The concentration of tocols was optimised at 22MPa and 40°C for CPO. The selectivity of tocols follows the preference of δ-tocotrienol>γ-tocotrienol>α-tocotrienol>α-tocopherol.