106th AOCS Annual Meeting and Industry Showcases

Processing Division Technical Program Abstracts

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The presenter is the first author or otherwise indicated with an asterisk (*).

PRO 1: Leadership

Chairs: M.J. Boyer, Agribusiness and Water Technology, USA; and G. Mitchell, Process Plus LLC, USA

Manufacturing and Business Development Based Upon Dr. Kazuo Inamori's Management Business Philosophy. R. Heistand, II, Southcoast Container Services, USA.

Dr. Kazuo Inamori was an unusual Japanese entrepreneur who founded a fine ceramic manufacturing company, Kyocera Inc., 56 years ago. He personally grew it to a $12B international family of companies. Early in his career he developed 12 management principles which he has continued to hone and still teaches today.

Having started a new business within one of the Kyocera group companies, I will illustrate 6 of these principals with examples from integrated passive microelectronics manufacturing and business development:

1. *Set specific goals*. Once targets are set, share them with all employees.

2. *Keep a passionate desire in your heart.* Your desire must be strong and persistent to penetrate into your subconscious.

3. *Strive harder than anyone else.* Work steadily and diligently, one step at a time, never relenting in tedious tasks.

4. *Success is determined by willpower.* Business management requires a persistent "rock-piercing" will.

5. *Always be creative in your work.* Innovate and improve continuously. Today should be better than yesterday; tomorrow, better than today.

6. *Be kind and sincere.* Business is based on partnerships and must bring happiness to all parties.

Safety Leadership. M.A. Snow, Bunge Ltd., USA.

There are many elements in our organizations that work together to contribute to keeping workers safe. Among other things, we have policies, procedures, work permits, we train workers, we provide personal protective equipment, we have physical attributes to our facilities that keep workers safe, etc. One of, if not the most important element to the effectiveness of our safety programs, is the element of leadership. This oral presentation will focus on why leadership is important and what are some things leaders can do to contribute to the advancement of safety in our organizations?

Leadership in the Food Industry...an R&D Perspective. S. Hill, Kraft Foods, USA.

When I began my career in the food industry 23 years ago, I did not understand the importance of leadership in the corporate research and development function. Over the years, I gained insight and appreciation for the skills, competencies, values, and beliefs required to become a successful leader. Research and development organizations are full of scientists who have been achievement oriented and successful delivering results all their life. What sets apart leaders from contributors are traits that center on capabilities such as communication and influence, building strong vast diverse networks, and courage. In this talk, I will explore and discuss how these capabilities are leveraged by successful leaders in R&D.

Leadership in Manufacturing and Operations. B. Minor, CHS, Inc., USA.

Much has been written on the art and science of leadership and new theories emerge daily, yet effective leadership remains a rarity. The challenge of leadership in the world of operations is particularly difficult as the leader must be equally effective on the shop floor and in the boardroom. The intent of this oral presentation will be to share the fundamentals of two relatively new leadership techniques; Servant Leadership and Strengths-Based Leadership, which are proving very effective with today's multigenerational workforce.

Leadership in Environmental Management and Sustainability. M.J. Boyer, Agribusiness and Water Technology, Inc., USA.

Management of environmental and sustainability programs requires experience and skills that match the changing and regulatory nature of the challenge. History tells us that the type of manager who fills this position changes over time from policy based to technology/science based backgrounds. The skill set for leadership in this area is consistent with leadership skills in manufacturing and other areas. To be successful the leader must command respect, not demand respect.

PRO 2/BIO 2.1/IOP 2: Alternative Fuels and Enzymatic Biodiesel

Chairs: S. Lewis, Solenis, USA; H.C. Holm, Novozymes A/S, Denmark; R.M. Burton, MARC-IV Consulting, Inc., and USA; G. Knothe, USDA, ARS, NCAUR, USA

Development of Enzymatic Catalyzed Fat-splitting Processes. A. Rancke-Madsen, P.M. Nielsen, and H.C. Holm, Novozymes A/S, Denmark.

Conventional thermal fat-splitting processes suffer from expensive and complex equipment, high energy consumption, product quality problems like *trans* fats and color formation and hazardous work environment. Enzymatic catalyzed fat-splitting processes are attractive potential alternatives but enzymatic processes still only have very limited industrial uses, mainly due to insufficient temperature stability and relatively high cost of current enzymes like *Candida rugosa lipase.*

Thermostable lipases expressed in high yields by industrially relevant host systems have been tested at 55C/131F in 100 ml shaking glass reactor system using a wide range of feed-stocks, including tallow and acid oil waste materials, 30% water w/w and 0.1-1.0% w/w enzyme solution.

The results suggest new lipases have been identified which are superior to traditional fat-splitting lipases, due to better thermostability, lower cost and high reaction rates. Kinetic studies and initial engineering assessments suggest enzymatic catalyzed fat-splitting technology will become successful in the industries within a few years.

Evaluation of Glycerol Carbonate Production and Its Cosynthesis in Enzymatic Biodiesel Production. R.M. Burton[1] and J. Greenstein[2], [1]MARC-IV Consulting, Inc., USA, [2]North Carolina State University, USA.

Glycerol is a byproduct of biodiesel production. In large centralized biodiesel production facilities, glycerol may be refined to a high purity product. Yet for many biodiesel plants crude biodiesel glycerin is still a waste concern. Glycerol (1,2,3-propane triol) is a trifunctional molecule that can be modified to produce a wide range of products. Glycerol carbonate (GC) and glycidol (2,3-epoxy-1-propanol) are key intermediates in the production of many of these products. GC is a “platform chemical” which can help substitute bio-based feedstocks for the current petroleum derived sources. Recently, researchers have begun investigating the use of enzymes to convert glycerol to glycerol carbonate. In addition, biodiesel production using enzymatic catalysis has also moved from the research phase to the commercial arena. When enzymatic catalysis is employed for biodiesel production, there is an opportunity to obtain a higher quality of glycerol co-product. This higher glycerol quality may allow an easier processing to new biobased materials. Here, we will evaluate both the enzymatic conversion of glycerol to glycerol carbonate as well as the enzymatic co-synthesis pathway of biodiesel and glycerol carbonate together.

New Developments in Enzymatic Catalyzed Biodiesel Improve the Process Significantly. P.M. Nielsen, A. Rancke-Madsen, T. Balle, B. Knuthsen, and H.C. Holm, Novozymes, Denmark.

The enzymatic catalyzed biodiesel has been in large scale production for more than two years most of the time in a test period in a few plants, but now it also available for all biodiesel producers. During that period a lot have been learned and the process has been improved.

The technical improvements in the process and lower enzyme costs open the possibility of using the enzyme for one batch only. This has some big impacts on how the process can be designed. In the presentation we will discuss the implications of one time use of liquid lipase including: the reaction can be operated at higher temperature and methanol concentrations leading to shorter reaction time and easier separation of heavy phase after the reaction. The downstream process for enzyme recovery can be omitted, and it opens for the possibility of continuous reaction system.

Continuous Enzymatic Biodiesel Processing. B. Chrabas, Viesel Fuel, LLC, USA.

Feedstock costs are recognized as the highest variable cost in the production of biodiesel accounting for up to 80 % of the material costs associated with making a gallon of biodiesel. The Enzymatic Biodiesel Pathway allows for the use of feedstocks which are lower in cost by comparison and have limited use in conventional biodiesel processes.

The ability to optimize process inputs in a continuous system lead to the development of the Continuous Enzymatic Biodiesel Process. Working in collaboration with Novozyme , Tactical Fabrication, and Purolite, the Skunkworks Team is pioneering the

use of enzymes in their Continuous Enzymatic Biodiesel Process.

The Continuous Enzymatic Biodiesel Process being demonstrated by Viesel Skunk Works, LLC at its World Headquarters in Stuart, FL has been used as a test-bed for the scalable process.

The basic tools required for an enzymatic biodiesel laboratory and how they aid in determining the suitability of various lower cost feedstocks will be outlined in this presentation accompanied by production data taken from the Continuous Enzymatic Biodiesel Processor.

Cold Flow Properties of Fatty Acid Methyl Esters: Additives versus Diluents. R.O. Dunn, USDA, ARS, NCAUR, USA.

Biodiesel is typically composed of fatty acid methyl esters (FAME) converted from agricultural lipids. Common feedstocks include soybean, canola, rapeseed, sunflower and palm oils. Recent debate on the conversion of edible oils into non-food products has created opportunities to develop alternative non-edible feedstocks such as jatropha and used cooking oils, waste grease and animal fat. The cold flow properties of biodiesel are poor compared to conventional diesel fuel (petrodiesel). Vehicles fueled by biodiesel/petrodiesel blends may experience start-up and operability problems if exposed to overnight temperatures below the cloud point (CP). Performance issues are exacerbated when the biodiesel is made from high-saturated fatty acid feedstocks including palm oil and many of the aforementioned non-edible oils. Technical strategies have been devised to improve the cold flow properties of biodiesel. Although cold flow improver (CFI) additives can decrease pour point (PP) and cold flow plugging point (CFPP), these additives do not significantly improve the CP when employed at low concentrations (< 1%) in biodiesel and biodiesel/petrodiesel blends. However, increasing the concentration of some additives (diluents) was more effective. This report provides an updated perspective on the development of new CFI additives and diluents for biodiesel.

Fuel Quality Sensors for Characterization of Biofuels and Determination of Their Aging Degree. J. Krahl, M. Eskiner, and Z. Fan, Coburg University of Applied Sciences and Arts, Germany.

A fuel sensor should prevent engines from damages in the fuel line or the combustion chamber or the exhaust gas treatment system. Two sensor principles are introduced to control the quality and the age of biofuels: Dielectric relaxation and fluorescence spectroscopy.

The detection principle of the newly designed dielectric sensors for determining the aging degree is based on dielectric relaxation spectroscopy. The sensor is characterized by its simplicity, its small size and low price. A possible future use could be the installation in fuel tanks to control the oligomer concentration.

By measuring the real and imaginary part of permittivity in a broad frequency range, it is possible to observe relaxation processes, because of a lag in response of high-molecular and polar oxidation products from biodiesel in the alternating electric field.

Time resolved laser induced spectroscopy (TRLSF) allows identification and quantification of diesel fuel without sample preparation. Applying a mathematical principal component analysis allows the determination of FAME from different feedstocks in diesel fuel. In a further development step a miniaturization of fluorescence sensor was achieved. This LFS-prototype provides approximately similar features as the TRLFS, but without time resolution.

Three Approaches to Fuels from Fatty Compounds. G. Knothe, K.M. Doll, B.R. Moser, and R.E. Murray, USDA, ARS, NCAUR, USA.

Biodiesel, the alkyl esters, usually methyl esters, of vegetable oils, animal fats or other triacylglycerol-containing materials, are the most common approach to producing a fuel from the mentioned materials. This fuel is obtained by transesterifying the oil or fat with an alcohol, usually methanol, in presence of a catalyst such as alkoxide or hydroxide. In more recent years, a fuel probably best termed renewable diesel has been developed which simulates the composition of conventional diesel fuel. This fuel is obtained by hydrotreatment of the triacylglycerol-containing materials. Even more recently, a decarboxylation process of fatty acids was reported which provides a mixture of long-chain alkene isomers and other products with potential fuel properties. The three materials are compared regarding their production, composition and properties.

PRO 3: New Technology

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

Technology in Development - Continuous Yield Improvements. E. Ventrici, Molinos Rio de La Plata S.A., Argentina.

Abstract not available.

Latest Developments in Physical Refining of Seed Oils. W. Younggreen, Alfa Laval Inc., USA.

Abstract not available.

Solutions for Handling Enzymatic Degumming By-products. M. Shindelar, M. Dasari, and A. Mafhuz, Feed Energy Co., USA.

Soapstock and gums are by product of chemical and physical refining process for vegetable oils and animal fats. These are unstable in nature and generally find their way into animal feed after being chemically processed. The new enzymatic degumming process yields a viscous gum type byproduct with high moisture content. This presentation will discuss about its physical and chemical characteristics as compared to traditional soapstocks and some solutions to add value to this new byproduct stream.

A Field Perspective on Best Practices for Enzymatic Degumming. S. Gregory, DSM Food Specialties, USA.

The oilseed industry is adopting the use of enzymes for vegetable oil degumming worldwide. Higher oil yields, lower fat in meal and physical refining potential are the drivers for most plants. A successful implementation of this cutting edge technology requires proper engineering and equipment selection. Using practices learned from startup and optimization in many plants worldwide, a practical discussion of some of the most important factors for success will be covered.

Enzymes Bring Innovation to Oils and Fats Processing: Past, Present, Future. H.C. Holm, Novozymes A/S, Denmark.

Biotechnology has enabled cost effective production of a variety of enzymes that improve the processes and final products for a number of industrial producers. The production of enzymes from screening in nature to final product will be shown. As well as case stories showing how enzymes have replaced harsh chemicals and improved final products. In oils and fats industry enzymes is now a standard processing aid in a number of production processes, it will be presented how:·lipases has been used and are used for specialty fats products, like CBE and infant milk replacers lipases are used in production of margarine and shortenings enabling production free of trans fatty acids formation, phospholipases removes phospholipids from oils ensuring high processing yields and improved process economy for refining of oil lipases will revolutionize the biodiesel industry cellulases will improve production yield in palm oil processing.

Oil Yield Calculation from Enzymatic Degumming Process. D. Walsh, DSM Food Specialties, USA.

Significant economic benefits can be realized through the use of phospholipase enzymes in vegetable oil degumming or refining. These enzymatic degumming/refining processes are becoming widely adopted worldwide. Specifically, phospholipases have the ability to hydrolyze phospholipids—the major crude oil impurity that contributes to oil losses—into oil and water soluble fractions, leading to an oil yield increase (reduction in losses). This oil yield can be measured at the plant using both mass-flow meters and tank volumes, laboratory-generated models also serve to predict the oil yield that can be obtained.

Enzymatic Gums Deoiling: A Flexible Process for Increasing Oil Yield. W. De Greyt, Desmet Ballestra Group SA, Belgium.

Abstract not available.

Advanced Process Simulation Applied to Deodorization and Physical Refining Processes. M.C. Usseglio[1,2], [1]National University of La Plata, Argentina, [2]ProSimTechs, USA.

Deodorization is one of the most important stages in a vegetable oil refinery. Small increases in yield, quality enhancements in outlet streams and reductions of energy cost (steam) can bring significant gains in productivity and revenues.

In process optimization tasks, while the execution of industrial tests implies to rely only in experimentation (always associated with a given inherent risk), process modeling and simulation studies, in conjunction with lab results of key samples and actual process conditions, allows to get a wider scope of these optimization activities, by predicting the characteristics of outlet streams and

by analyzing almost an unlimited number of process simulation scenarios, aiming to select best processing scenario, reducing time, cost and degree of uncertainty of industrial plant tests.

In this presentation, it is shown through a Case Study of Deodorization how the use of studies of Advanced Process Modeling allow to, successfully, execute a process optimization in rigorous way, by analyzing the impact of key process variables (stripping temperature, stripping steam flowrate and vacuum) on quality parameters (composition of free fatty acids, tocopherols, glycerides, sitosterol, etc) of refined oil and distillate streams.

PRO 4a: Innovative Solutions

Chairs: A. Subieta, Desmet Ballestra North American, Inc., USA; and J. Willits, Desmet Ballestra North American, Inc., USA

A Safe, Profitable, and Sustainable Method for Disposal of Spent Bleaching Earth. N.J. Smallwood, The Core Team, USA.

Due to the rapid oxidation of the retained oil, spent bleaching earth is vulnerable to spontaneous combustion. There are safety, expense and environmental issues involved in disposal for edible oil processors. Solid waste disposal involving prompt coverage with soil has and continues to be the dominant practice. By mixing spent bleaching earth with sufficient salt to eliminate the spontaneous combustion hazard and adding other ingredients, livestock health and nutritional products can be produced. This invention provides a simple and practical method for the safe, profitable and environmentally friendly disposal of spent bleaching earth for processors worldwide.

Novel Methods to Improve Oil Recoveries from Canola and Sunflower. P. Adu-Peasah, S. Wensing, M. Robinson, P. Nelson, T. Patterson, A. Bowling, and H. Pence, Dow AgroSciences, USA.

Most traditional oilseed crushing facilities use organic solvents (primarily hexane) for solvent extraction. However, growing awareness of the deleterious effects of organic solvents on the environment and human health has increased the public scrutiny. These concerns have prompted some of the newer plants to omit solvent extraction entirely and only mechanically press the seed. However, oil recoveries from such plants are typically lower than 90% (compared to over 95% obtained from traditional solvent extraction plants). In this presentation, methods using enzyme to assist mechanical pressing will be discussed. Commercial grade canola and dehulled sunflower flakes were treated with commercial grade enzymes obtained from Novozymes (Celluclast®, Viscozyme® and Flavourzyme®). The flakes were treated with different amounts of enzymes (0.125 and 0.250%), moisture contents (15 and 30wt.%) and holding times (6 and 16hrs). Treated flakes were dried to 7-8wt.%, heated and mechanically pressed to recover oil. Oil recoveries greater than 90% were obtained for some treatments. Crude oils with very low phospholipids were produced. The canola meal produced had comparable quality to the commercial grade canola meal. Detailed results of impact of enzyme treatment on oil recovery, quality of oil and meal, and process economics will be discussed in this presentation.

How to Reduce 10% on the Steam Consumption in Oil Seed Crushing Plants. A. Demarco, Desmet Ballestra, Argentina.

There are some “hot” streams (liquid and vapor ones) in the oil seed crushing plants that today are wasted and lost to the atmosphere. These lost BTU's (Kcal’s) can be re-used to improve the thermal performance and consequently reduce the operation costs of the plant.

This presentation describes how to re-use those “hot” streams in a balanced and sustainable approach in both soybean and canola/rapeseed installations.

Evaluating Vacuum Systems for Planned Upgrades in New Plant. C. Braungart, Graham Manufacturing, USA.

As demand for edible oils steadily increases, ejector systems slated for new plant installations need to be evaluated to account for future design considerations. Developing a progressive approach to upgrading provides an attractive option which can streamline changes required for revamps when implemented. Information presented focuses on multi-stage ejector packages used in deodorizer systems. Options are based on a vacuum system design to include a 50% increase in capacity requirement. Costs, design conditions, equipment sizing, and piping arrangements are explored which outline strategies for a planned revamp. Advantages result in reduced field work for new installation, cost for upgrade, and engineering input.

PRO 4b: Industry Update

Chairs: A. Subieta, Desmet Ballestra North American, Inc., USA; and J. Willits, Desmet Ballestra North American, Inc., USA

FDA FSMA Preventive Controls for Animal Food—Understanding What Processors Need to Do. D. Smith, Projects Inc., USA.

In 2011, the Food Safety Modernization Act (FSMA) authorized the FDA to develop rules for preventive controls for animal food. These rules affect processors that produce and sell soybean and canola meal in the US. The new rules are expected to become efective in August, 2015. Key elements of this requirement are 1) developing and implementing current good manufacturing practices, 2) developing and implementing a Food Safety Plan (FSP), 3) performing a Hazard Analysis of Risk Based Controls (HARPC), and 4) appointing a trained and/or experienced Qualified Individual (QI). This presentation reviews the current status of the FDA program and identifies steps to take to implement the program at your facility.

Transforming the Soy Value Chain: How Soybean Composition, Varieties, Processing Techniques, and Profit Margins Will Cause Change. G.B. Denny, Gordon Denny, LLC, USA.

Changes among all links in the Soybean Value Chain are occurring at a pace and magnitude never before seen in history. Records are being broken almost daily in significant areas like domestic crush volumes, crush margins, exports and feeding margins. The profit ratios of crush margins are trending much more toward Soybean Meal vs. Soybean Oil. The commercialization of High Oleic Soybean oil and its soon to be obtained “Critical Mass” acceptance by farmers, processors and end-users is significant. At least equally significant are new trait-enhanced soybean varieties that will provide yield parity plus a 4-5 % increase in protein. Improved openness, communication and trust between value chain members along with soybean processors considering production of “Optimum Quality Soybean Meal” will likely lead to a need for a “Premium Scale” for Soybean Meal vs. just the current NOPA scale of discounts. With domestic soybeans having a great Sustainability story, consumer acceptance appears to be growing. New soybean seed traits, consistent growth in demand and competitive increases in soybean farmer profitability will ensure a strong, consistent and viable soybean value chain for decades. Learn how you might share in that growth.

Heat Transfer—Fundamentals for Energy Recovery Optimization in Preparation. F. Skold, Solex Thermal Science, Canada.

For the proper design and optimisation of all energy recovery systems it is crucial to get right the basics of heat transfer modelling and design. This paper explores the underlying correlations and assumptions used in thermal modeling of the critical equipment used in energy recovery setup. The paper will further delve into parameters and operational considerations that affect the overall savings. The presentation focuses on the preparation plants and use of indirect heating of seeds and grains as an example.

New Trends in Alkaline Refining to Produce High Quality Edible Oil. S. Hruschka, GEA Westfalia Separator Group GmbH, Germany.

All the processes for edible oil refiing feature the common goal that, besides the hydratable phospholipids PL, primarily Phosphatidylcholin and Phosphatidylinositol (PC and PI), the non-hydratable phospholipids NHP, primarily Phosphatidylethanolamin and Phosphatidyl Acid (PE and PA), also have to be removed from the oil. Whereas the hydratable PL form a heavy phase with water with no accompanying chemical reaction, separation of the NHPs requires a chemical reaction, initially triggered by salt formation with the Ca from the PA links and the added acid, before the polar lipid is hydratable.

There are some trends in order to reduce the demands for chemicals like acid and caustic, e.g. realized with the implementation of an improved reaction technology like the Nano Reactor. But another trend or demand can be observed too: to separate valuable byproducts like simple lecithin or lecithin derivats with reduced oil content or to recover special lipoid fractions as single substance dispersion or suspension. And the third point to consider is the improved quality of the oil phase, meaning a reduced phosphorus, Ca, K, Fe etc. content in the (semi) refined oil.

PRO 5: General Processing

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

Effect of High Intensity Ultrasound on Crystallization Behavior of High Stearic High Oleic Sunflower Oil Soft Stearin. J. Rincon-Cardona[2], L. Agudelo-Laverde[3], M.L. Herrera[3], and S. Martini*[1], [1]Utah State University, USA, [2]Universidad Nacional de San Martin, Argentina, [3]Instituto de Tecnologia de Polimeros y Nanotechnologia, Argentina.

The objective of this research was to evaluate the effect of high intensity ultrasound (HIU) and crystallization temperature (T_c) on the crystallization behavior, melting profile, and elasticity of a soft stearin fraction of high stearic high oleic sunflower oil. Results showed that HIU can be used to induce and increase the rate of crystallization of the soft stearin with significantly higher SFC values obtained in the sonicated samples, especially at higher T_c. SFC values were fitted using the Avrami model and higher k_n and lower n values were obtained when samples were crystallized with sonication suggesting that sonicated samples crystallized faster and through an instantaneous nucleation mechanism. In addition, crystal morphology, melting behavior, and viscoelasticity was significantly affected by sonication.

Mechanical Pressing of Tiger Nut Oil: Effect of High Pressure Processing and Enzymatic Pre-treatment on Oil Recovery and Quality. O. Ezeh, K. Niranjan, and M.H. Gordon, University of Reading, UK.

Tiger nut (*Cyperus esculentus*) oil makes up about 26% of the tiger nut tuber. High pressure processing (300-700MPa) and enzymes were used as pre-treatments prior to oil extraction by use of a hydraulic press to investigave their influences on the oil recovery and polyphenol content. All pressures used did not contribute to any increase in oil recovery. A combination of protease, a-amylase, and a mixture of carbohydralases, on the other hand did lead to a significant increase in oil recovery. An enzyme to substrate ratio of 1% was found to give the highest recovery of 88%. The polyphenol compounds found in the enzymatically pressed oil is also given.

Supercritical Carbon Dioxide Extraction of n-3 LC-PUFA Oil from *Nannochloropsis* by Optimization of Process Parameters Using Response Surface Methodology. C. Bruneel[1], K. Goiris[2], C. Dejonghe[1], L. Balduyck[1], S. Bijttebier[2], L. De Cooman[1], and I. Foubert[3], [1]KULeuven Kulak, Belgium, [2]KULeuven Campus Gent, Belgium, [3]VITO, Belgium.

Important health benefits are associated with n-3 long chain polyunsaturated fatty acids (LC-PUFA), more in particular with eicosapentaenoic acid and docosahexaenoic acid. However, current global n-3 LC-PUFA intake is insufficient and the traditional n-3 LC-PUFA source, fish, is declining. A promising alternative and sustainable n-3 LC-PUFA source are microalgae. They contain, next to n-3 LC-PUFA, other nutritionally interesting high value compounds. A central composite design procedure was used to investigate the impact of operating pressure (200 – 400bar), operating temperature (50 – 70°C), extraction time (60 – 120min) and percentages of ethanol added as a modifier (0 – 8mole%) of supercritical carbon dioxide extraction on total lipid yield and the yield of high value compounds from *Nannochloropsis*. The optimal condition for total lipid yield and the yield of high value compounds within the experimental range of the variables was at 400bar, 50°C, 120min and 8mole% ethanol. At these optimal conditions, a total lipid recovery of 50% was obtained which is similar as when lipids were extracted from *Nannochloropsis* using hexane/isopropanol (3:2). However, the latter solvent yielded a higher recovery of polar lipids and carotenoids.

The Effects of Oilseeds Tg and Phospholipids Polymorphism on Mechanically Pressed Raw Oil Phospholipids Content and Expeller Oil Expression Efficiency: The Cryo-press Process. M.F. Novaes and N.J. Hewitt, University of Ulster, UK.

Mechanical oil extraction of vegetable oils requires the breakdown of the oilseeds cell walls and the rupture of the oil droplets membranes for the efficient extraction of the oils.

Oilseeds cells walls are composed of natural amorphous polymers and as such it has a glass transition temperature (Tg) that is inversely related to the seeds moisture content.

Oil droplets membranes are mainly composed of a mixture of phospholipids systems that can self

assembly into different phase dispersion structures, a behaviour known as polymorphism.

A novel vegetable oil mechanical extraction process, hereafter referred to as Cryo-press, has been successfully developed and tested at CST, University of Ulster, with the intention of eliminating the need for the degumming process. The Cryo-press process takes advantage of the seeds Tg dependence on M.C. and phospholipids polymorphism to produce raw oils with phosphorous content as low as 3ppm and magnesium and calcium contents as low as 1ppm.

In this paper we compare the raw oil phospholipids content and expeller oil extraction efficiencies for rapeseed pressed in a high efficiency lab expeller, also developed at CST, at 3 different press conditions: Hot press, cold press and Cryo-press.

White Flake Desolventization. R. Ozer, Crown Iron Works Co., USA.

Soy White Flakes are starting point for high value Soy Products for the Food Industry including Soy Protein Isolate or Concentrate or as a starting material for Texturized Vegetable Proteins. A wide variety of other applications in the Food Industry are available for Soy White Flakes as well.

This paper will briefly discuss applications for the White Flakes themselves. The paper will then go into detail on the methods of White Flake Desolventization provided by Crown Iron Works which includes Direct Contact Desolventization, Indirect Contact Desolventization, and Desolventization under vacuum.

We will also discuss the possibility of producing White Flakes from other common Oil Seeds.

Industrial Studies of Contaminants Removal by Oil Refining. X. Pages, M. Gaud, C. Segalen, J. Buchoux, and M. Gouban, ITERG, France.

The presence of contaminants in oils may have many different origins. Environment may induce crops contamination with metals, dioxins, & polychlorobiphenyls from industrial wastes, polycyclic aromatic hydrocarbons, or mineral oil from vehicle exhausts. Crop protection implements chemicals like pesticides. Production process, transport, storage, contact with plastic material may also be contamination sources.

Although the potential toxicity of most of these contaminants is real, poisoning risks are rather limited due to the efficient elimination during the refining, careful conditioning, efficient packaging, and industrial quality control management.

Industrial studies have been done by ITERG to evaluate the key factors for removing these contaminants. Main characteristics to consider are: water solubility, octanol/water partition factor, chemical reactivity, molecular weight, vapor pressure and thermal stability. Operating conditions of refining are essential.

This presentation focuses on the removal of pesticides from different families: organochlorous, organophosphorous and pyrethroids.

Next Generation in Oil Processing: What (R)evolution to Expect in Near Future. M.J. Kellens, Desmet Ballestra, Belgium.

Increasing oil quality demands and more stringent limits for unwanted minor-components are challenging today's refining industry to seek for new solutions and adapt its processing route. On top, environmental and economic concerns drive refineries to become more sustainable and most cost-efficient.

With a vegetable oils and fats market being dominated by palm oil and soybean oil, it is evident that most new solutions are tailored on those two major oils.

The shift from conventional chemical to physical refining is further stimulated with the introduction of more performing enzymes, especially in degumming. But at the same time, novel processes like nano-neutralization are promoting the chemical route, especially when oils of varying quality are to be processed or very mild refining conditions are needed, to prevent or minimize side reactions typically linked to high temperature treatments. In oil bleaching, the trend is to optimize further the earth usage as well as to apply various types (activated or natural earths, special adsorption and filter aids like Trysil and Filtracel) in a single process, operating co- or countercurrent.

Deodorizing is done more and more at lower temperature, hence lower pressure is needed: ice condensing is becoming the standard for modern plants as they have a true economic value.

Recovering Usable Energy From Low Value Industrial Sources. A. Ward and M. Berkshire*, Process Plus, USA.

The concept of this study is to consider a method by which usable energy may be recovered from low value energy sources. The technology being considered for this application is the Seebeck

Cell Thermoelectric Generator. This cell makes use of a temperature differential that generates a voltage in the cell, creating usable power when applied in bulk.

This paper will examine the available energy in traditionally low value streams in processing and production plants and will seek to determine needs to generate usable power for a set of typical low value energy streams. Area and temperature differential are the primary variables of consideration as the performance of the device is a function of the area of the cell array and temperature difference across it. Cell materials and configurations will be evaluated and heat transfer calculations performed to validate the sizing basis. Additionally, the distribution of current and voltage will be considered for viability.

Streams presently under consideration are tower water return pipelines, desolventizer cooler air ducts, and post-economizer flue gas stacks. In addition to determining the necessary areas, the paper will examine the necessary costs and the returns on investment to apply the technology.

Future work will be to detail the financial considerations and to investigate potential fabrication methods for arrays.

PRO-P: Processing Poster Session

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

1. **Biodiesel Production from Acid and Saturated Frying Oil, Using Corona Discharge Plasma Technology.** A. Leal Vieira Cubas[2], M. Medeiros Machado[1,2], E.H. Siegel Moecke[2], and C.R. Silva de Carvalho Pinto[1], [1]Universidade Federal de Santa Catarina, Brazil, [2]Universidade do Sul de Santa Catarina, Brazil.

Oils and fats when used repeatedly in the frying process suffer various physical and chemical alterations. These reactions can form undesirable and harmful compounds to human health such as free fatty acids. This oil dumped in drains and sinks attracts urban pests and damage the sewage networks. In the environment, this oil creates a barrier on the rivers that inhibits the entrance of light and oxygenation of the water, thus undermining the basis of the aquatic food chain. The proposed paper refers to the production of a renewable source of energy, the biodiesel from waste oil, that uses corona discharge plasma technology, which the high-energy atmosphere replaces the use of acidic or basic catalysts, presenting advantages as: accelerate the esterification reaction; facilitate the biodiesel separation; eliminate the waste generation during the manufacture of biodiesel, such as acids, alkalis and glycerol as well as producing superior quality biodiesel which, when burned, releases fewer pollutants in the atmosphere than the biodiesel obtained by traditional process. This project is considered an innovative process due to non effluents generation, especially glycerol, which in the traditional process generate 10% glycerol.

2. **A New Industry Model for Predicting Oil Yield in Enzymatically Assisted Degumming of Vegetable Oil.** S. Konradt, AB Enzymes GmbH, Germany.

Objective: The addition of Phospholipases in edible oil degumming has been considered many years, and applied in multiple industrial cases. The original objective of the enzyme treatment was a reduction of phosphorus. Now, with enzyme assisted oil degumming being established, another variable should be considered to suggest enzyme assisted degumming: refined oil yield in relation to the amount of crude oil input.

Phospholipase (A2) releases a fatty acid from Phospholipids, changing them into Lysophospholipids. This fatty acid release influences the hydrophilic-lipophilic-balance (HLB value) of the molecule and thus its emulsification properties which positively affects neutral oil recovery.

Method & Results: A calculation method was designed to optimize the enzyme assisted oil degumming in relation to varying raw material qualities. The method was challenged at pilot scale and showed a high level of oil yield predictability.

Conclusion: The specificity of the enzyme in combination with the calculation model allows better prediction of potential oil yield increase. This allows for determination of enzyme dosage at industrial scale (based on phosphorus content of the crude oil) and helps to optimize the treatment of ever fluctuating raw material qualities.

3. **Cedarwood Oil in Water Formulations for Pressure-treating Wood.** F.J. Eller, USDA, ARS, NCAUR, USA.

Cedarwood oil has previously been demonstrated to confer resistance to otherwise non-resistant wood. This earlier research involved the use of ethanol as the carrier solvent to impregnate the wood. For several reasons, a better carrier for the cedarwood oil was desired. In this current study, several methods for preparing stable yet non-permanent dispersions of cedarwood oil in water were examined for pressure-treating wood.

4. **Adsorptive Performance of Bleaching Clays in Soybean Oils Based on Adsorption of Chlorophylloid Analogs and Deodorized Oil Color.** D. Brooks and A. Litin, Oil-Dri Corp. of America, USA.

The impact of moisture and citric acid addition on the adsorption efficacy of two bleaching clays, a natural clay and an acid treated clay, was evaluated in “typical” and “difficult-to-bleach-green” soybean oils. Adsorption of chlorophylloids and deodorized red color were used to measure bleaching efficiency. Starting oil and bleached oil chlorophylloid content, as determined by reverse phase HPLC using fluorescence detection, varied significantly across oil source and bleaching conditions with respect to starting oil concentrations and molecular ratios of chlorophyll -a and -b analogs. Moisture and citric acid addition during the bleaching stage improved bleaching performance (chlorophylloids and deodorized red color) for both clays. Acidity in the system, including clay pH and citric acid, played a

prominent role in improving bleaching efficiency across the soybean oils treated.

5. **Extraction of Omega-3-rich Oil from C*amelina sativa* Seed Using Supercritical Carbon Dioxide.** H.D. Belayneh, O.N. Ciftci, and R.L. Wehling, University of Nebraska-Lincoln, USA.

Supercritical carbon dioxide (SC-CO2) is a desired green solvent for the extraction of omega-3 oils; however, there is no reported study on the SC-CO_2 extraction of *Camelina* seed oil. Therefore, the objective of this study was to evaluate SC-CO_2 for the extraction of *Camelina* seed oil. Response surface methodology based on central composite rotatable design was employed to investigate the extraction conditions: pressure (35-45MPa), temperature (50-70°C), and time (90-250min). A second order polynomial model was developed to predict the oil yield (wt.%). Increasing pressure and time increased the oil yield, whereas increasing temperature did not have a significant effect. Optimal conditions (45MPa, 70°C and 224.5min) yielded 27.0% oil, whereas the actual yield was 25.1 ± 2.0%. Oil yield was further increased to 31.6 ± 3.1 by increasing the SC-CO_2 extraction time to 510min. Soxhlet (hexane) and screw press methods yielded 35.9 ± 1.3% and 29.9±1.0% oil, respectively. Extraction method did not have a significant effect on the fatty acid composition and tocol content (P>0.05). Results indicated that SC-CO_2 is a promising green fluid for the extraction of *Camelina* seed oil.

6. **Hydroprime® Modular Plants Provide Low Cost, Reliable Hydrogen.** G. Shahani[1], K. Finley[1], N. Onelli[2], S. Parente[1], and L. Lyda[1], [1]Linde Engineering North America, USA, [2]Linde Gas North America, USA.

The hydrogenation of fats and oils requires hydrogen gas, which can be provided by a variety of different methods such as electrolytic plants, conventional steam methane plants or truck-delivered bulk hydrogen. This paper provides an overview of a unique steam methane reformer, employing an integrated heat recovery system, which can reduce the cost and improve the reliability for relatively small industrial hydrogen consumers. These plants have a capacity of 0.15 – 0.3 MMSCFD (165 – 330Nm3/h), produce ultra-high purity hydrogen (99.999 %) at 200 psig (13.8barg), thereby reducing the need for product compression. These plants offer high reliability, and superior environmental and safety performance. The plants have demonstrated excellent results in actual commercial operation all over the world.

7. **Physicochemical Parameters of Smoothies: Stability Along Shelf-life.** M.A. Nunes, A.S.G. Costa, J.C.M. Barreira, R.C. Alves, A.F. Vinha, A. Rocha, and M.B.P.P. Oliveira, University of Porto, Portugal.

Smoothies are beverages containing fruit, vegetables, yoghurt or milk, representing typical replies to consumers' demanding for high quality, clean label and minimally processed products (1). Smoothies are expected to maintain freshness properties (flavor, taste, appearance, color) throughout shelf-life (2, 3). Herein, physicochemical (pH, total titratable acidity- TTA and total soluble solids- TSS) and chromatic (lightness- L*, chroma- C* and hue- H0) parameters were evaluated in 16 smoothies along shelf-life (0, 14th and 21st days). Different packing materials were tested: clear polyethylene terephthalate- PET; opaque high density polyethylene- HDPE; TetraPak®). Differences at the initial day were compared by hierarchical cluster analysis, while the evaluation of each parameter along shelf-life was compared using 1-way ANOVA. At the initial day, pH values of all smoothies were similar, except for those containing milk, which showed higher values; these formulations presented also the highest values in TSS and L*. Regarding TTA, formulations containing passion fruit presented the maximal values. Differences in C* and H0 were not particularly associated to any type of formulation. However, while physicochemical parameters were nearly stable throughout smoothies' shelf-life, chromatic parameters presented significant differences, increasing in most cases. The time-induced differences were not associated to any of the packing materials used. João C.M. Barreira and R.C. Alves are grateful to Fundação para a Ciência e a Tecnologia (FCT) for their post-doctoral research grants (SFRH/BPD/72802/2012 and SFRH/BPD/68883/2010, respectively), financed by POPH-QREN and subsidized by FSE and MCTES. This work received financial support from the European Union (FEDER funds through COMPETE) and National Funds (FCT) through project Pest-C/EQB/LA0006/2013. The work also received financial support from the European Union (FEDER funds) under the framework of QREN through Project NORTE-07-0124-FEDER-0000.

8. **Alternative Bio-based Solvents to n-Hexane for the Extraction of Rapeseed Oil: Theoretical COSMO-RS Simulations and Experimental Substitution Investigation from Laboratory to Pilot Plant Scale.** A.G. Sicaire[1], M. Abert-Vian[1], F. Fine*[2], F. Joffre[3], P. Carre[4], and F. Chemat[1], [1]Université d'Avignon et des Pays de Vaucluse, France, [2]CETIOM, France, [3]ITERG, France, [4]CREOL, France, [5]SAIPOL, France.

Currently, the most widely used solvent for extraction of vegetable oils is hexane given its various advantages such as ease of removal from the products, low boiling point and good lipid solubility. One of the major constituents of industrial hydrocarbons mixture is *n*-hexane; it is sourced from fossil resources and registered under the REACH Regulation as a category 2 reprotoxic and aquatic chronic toxic which makes its substitution desirable. The oilseed sector aims at anticipating regulatory concerns towards a more sustainable oil extraction process. Identifying new eco-friendly solvents turned out to be a major concern for the industry. The present study provides a preliminary theoretical assessment of the solubility of major compounds of rapeseed oil in several bio-based solvents thanks to COSMO-RS simulations. This software is used as a decision tool for the identification of potential alternatives to *n*-hexane. An experimental screening of these solvents was performed to validate the theoretical approach. 2-Methyltetrahydrofuran (MeTHF), a bio-based solvent, was selected to investigate its performance toward extraction yield, oil quality, kinetic of extraction and global manufacturing cost in comparison to *n*-hexane.

9. **Olive Pomace: A Preliminary Approach Intending Its Valorization.** M.A. Nunes, F.B. Pimentel, A.S.G. Costa, and M.B.P.P. Oliveira, University of Porto, Portugal.

Olive oil global production has more than doubled in the last 20 years with a high by-products disposal. The challenge for sustainability is to take advantage of by-products and to develop high added-value solutions with minor environmental impact. Olive pomace (OP) is the major by-product of the olive oil processing chain characterized by traces of fat and high levels of bioactive compounds. This feature anticipates new opportunities to recover functional ingredients for further applications.

This work presents preliminary results intending OP valorization. Samples were obtained from DOP olive oil region (Trás-Os-Montes, Portugal). In a first approach, OP oil was obtained by solid-liquid extraction and fatty acids and vitamin E profiles determined. Afterward, bioactive compounds were extracted from the defatted fraction. Total phenolic content (TPC) and antioxidant activity (DPPH? scavenging ability and FRAP) were evaluated.

OP extracts present a significant antioxidant activity and substantial TPC (1946.0±374.4mg GAE 100g-1). Regarding the fat amount (10.1±0.55g 100g-1 dry weight), it is valuable recover it for further uses. These preliminary results allow us to foresee an alternative source of bioactive compounds and fat for potential applications (food and cosmetics). This work has been supported by Project "OLIVALE – Desenvolvimento inovador para produção de azeite de qualidade superior e com menor impacto ambiental", funded by Portuguese ADI and QREN.

10. **Environmental Life Cycle Assessment of Rapeseed Production in France within a Public LCI-database of Agricultural Products.** S. Dauguet[1], F. Flenet[1], F. Fine*[1], V. Colomb[2], and P. Koch[3], [1]CETIOM, France, [2]ADEME, France, [3]Koch Consulting, Switzerland.

The aims of AGRIBALYSE® program are a harmonized methodological framework for the main crops cultivated in France, and collective validations at different stages of the LCI calculation. The Life Cycle Assessment results obtained for rapeseed and sunflower crops are presented.

The boundaries of our studied system were from cradle to farm gate; all up-stream processes were included but post-harvest operations were excluded. Our functional unit is one kilogram of harvested oilseed, in order to assess the environmental impacts of food products. However the functional unit used during the data collection was one hectare of rapeseed crop and results per kilogram were assessed using the average yield.

The main contributors to the selected environmental impacts were field emissions. Experimental data showed that the direct emissions calculated with the tier 1 IPCC method tended to be overestimated. The assessment of the effect of improved practices showed some improvements on environmental impacts.

During this project, best choices were made to evaluate at a national scale French agricultural productions and to produce valid LCI references. These results represent a step forward to share with the agricultural sector in order to promote environmental evaluation and good farming practices.

11. **Development of Adjustable-volume Expanded Bed Reactor for Continuous Biodiesel Production.** K. Yamazaki, N. Shibasaki-Kitakawa*, K. Nakashima, and T. Yonemoto, Tohoku University, Japan.

The anion-exchange resin has a high catalytic activity for transesterification of triglyceride with alcohol to produce biodiesel. The expanded bed reactor packed with the resin is very effective to construct the continuous production system. However, the resin swells or shrinks depending on the composition of surrounding solutions, so that the bed height changes significantly and the liquid phase, which does not take part in the reaction, appears in the upper part of the fixed volume column. We have proposed an adjustable-volume expanded bed reactor system. During the production, the bed height in the fixed volume column decreased by 14%, and consequently the residence time through the liquid phase was 37% of total residence time through the column. The column height of the proposed system was adjusted by moving a sealed plunger controlled by program not to affect the bed height. The extra liquid phase was omitted, so that the dilution effect by it disappeared and the solution in the column was quickly pushed out. Therefore, the biodiesel productivity in the adjustable-volume reactor system became higher than that in the fixed volume reactor system.

12. **Evaluation of Ethanol and 2-Propanol for Rapeseed Oil Extraction.** A. Quinsac[1], P. Carre[2], and F. Fine*[1], [1]CETIOM, France, [2]CREOL, France.

The current process to extract oil from oilseeds such as rapeseed or sunflower, involves three main steps: a) preparation of the seeds including conditioning and pressing, b) solvent extraction, c) solvent elimination from the oil and the residue. Hexane is commonly used by industry because of well-known technical and economic advantages. Nevertheless hexane has numerous drawbacks like high flammability, dangerousness for health and environment deleterious effects and then, research for alternative solvent is a relevant issue. In this study, ethanol and 2-propanol were studied and compared to hexane for rapeseed oil extraction. Our results showed that rapeseed meals with less than 2% of residual oil can be obtained with the three studied solvents: hexane, ethanol and isopropanol. Extraction efficiency was strongly correlated with solvent polarity: ethanol < isopropanol < hexane. Compared to hexane, partial extraction of polar compounds was also observed, that could lead to increase the quality of the residue (more protein and less glucosinolates) but could also make more difficult the oil refining. The moisture content in the material and the solvent should be maintained at a low level to make easier the solvent recycling. Considering the feasibility of a continuous extraction, results showed that 2POH was more promising than EtOH.

13. **Degradation of Aflatoxin B_1 in Peanut Meal by Electron Beam Irradiation.** R. Liu, J. Lu, M. Chang , Q. Jin, X. Wang*, Jiangnan University, China.

Aflatoxins are a group of highly toxic, mutagenic and carcinogenic compounds. Aflatoxin B_1 (AFB_1) is the most potent teratogen, mutagen and hepatocarcinogen among the various aflatoxins, and is classified as a Group 1 carcinogen by the IARC. Removal or degradation in salvaging food and feedstuff already contaminated with toxic fungal metabolites is a major concern. Electron beam irradiation (EBI) technology can be applied to destroy organic molecules through direct or indirect oxidation. However, whether it could be used in peanut meal detoxification, the exact nature and safety of the radiation products remain unknown.

A degradation study of AFB_1 in peanut meal was performed under EBI at different AFB_1 initial concentrations and water concentration in peanut meal. The degradation of AFB_1 between the selected ranges of concentrations was proved to follow pseudo first-order reaction kinetics well ($R_2 > 0.95$), and the AFB_1 degradation rate was lower following the order: 5 > 1 > 0.5ppm and 21.47% > 14.32% > 8.74% condition. The Ames test indicated that the mutagenic activity of EBI treated samples was completely lost compared with that of untreated samples, providing clues to the assessment of safety issues of EBI method applied in AFB_1 decontamination.