2010 Annual Meeting Abstracts

Processing

MONDAY

MORNING
PRO 1: Processing Hot Topics
Chair(s): N. Dunford, Oklahoma State University, USA; and J. Mulholland, N. Hunt Moore & Assoc Inc., USA

How Sustainability-related Issues are Affecting Business Practices Focusing on the Oil and Oilseed Processors. Erich Dumelin, Consultant, Zurich, Switzerland

(Food-) Manufacturers and processors objective is to serve customers and consumers with their daily needs. While traditional interests were mainly in the quality and price of a product, today?s customer and consumer also wants to know about the wider impacts of our products, e.g. including raw material sourcing and production processes. Responsible companies therefore become keen to assess their impact on the environment and the social partners along the total supply chain, and today?s processors not only have to meet the performance expectations of their products and optimize their production processes; they also have to put more effort into the selection and care of their raw materials and suppliers. Their commitment for the impacts of their products and services does not start and end at the factory gates. Sustainable behavior is not new, internal actions have been taken in the past albeit for different reasons most likely. Cost issues were the driving forces behind initiatives like energy savings, material losses, water consumption and/or effluent reduction, all also with significant impact on the environment. But the more recent drive for sustainability has different reasons, such as company policies for a more responsible behavior, the concern about the long-term availability of raw materials or also customer/consumer pressure. This look beyond the factory gate and along the total supply chain is more complex however. But it showed in many cases a larger impact of other supply chain steps on the environment relative to processing and transport, such as in the production or the choice of raw materials and ingredients. While there is often very limited flexibility in the choice to achieve the desired product functionality, there is more scope in the growing and production, i.e. by adhering to good agricultural practice. Opposite to the earlier actions in energy or material savings etc., quick wins might not be as obvious and the motivation therefore different. But the customer is setting the scene for his product requirements and expectations. To maintain the market opportunity, the processor's focus is therefore shifting from the finished product properties and safety only to a much closer engagement also with the supplier or grower of his raw materials. More and more he will be asked for the impacts of the total supply chain of his products, to make these more transparent and to commit to certain standards. In the processors very own interest however, sustainable behavior will not only help his reputation, but also to ensure long-term access to quality raw materials and therefore be a shared objective for the whole industry.

Sustainability: An Innovation Platform for Oil Seed Agriculture, Processing, and Products. Deborah Ross, Ian Purtle, Cargill, Incorporated, USA

Sustainability is generally defined as meeting the needs of today without compromising our ability to meet the needs of future generations. Most use the triple bottom-line definition of appreciating not just the economics of a business enterprise, but also environmental and social impacts. Today, we face of host of global macro trends centered on exponential population growth, diminishing sources of inexpensive energy, and potential carbon legislation to curb anthropogenic impacts on climate. Agriculture will be impacted by all of these trends. The purpose of this talk is to explore the opportunities and risks global agriculture will face to meet the demands of the world's food, feed, fuel and materials and its respective impact on the environment and society. Life cycle assessments of biofuels and bio-based materials derived from oil seeds will be presented to highlight the use of this tool as a way to appreciate the interconnectivity, complexity, and opportunities for agriculture.

***Trans* Free Production of Margarine Hardstocks.** G. van Duijn, Unilever R&D, Vlaardingen,The Netherlands

In response to adverse effects of Trans Fatty Acids (TFA) on blood cholesterol found in the early 1990s, the European margarine industry decided to eliminate TFA containing hardstocks from their margarine compositions. In 2003, the International Margarine Association of the countries of Europe (IMACE) set the target for retail margarines at max. 1 % TFA on product basis. Furthermore, the positive health effects of TFA reduction should not be counteracted by a replacement of TFA by saturated fats. TFA elimination without increasing saturated fat level was achieved by:1. Optimal hardstock characteristics which can stabilise a maximum of water-in-oil emulsion with a minimum of solid fat phase.2. The production of trans-free hardstocks by combination of full hydrogenation and/or re-arrangement and/or fractionation.The use of fully hydrogenated oils for hardstock production was gradually phased-out since consumers were advised to look for hydrogenation in the composition declaration as indication of TFA presence. Therefore, most of the current hardstocks in Europe are based on palm oil, the hard fraction of palm oil (palm stearin) and palm kernel oil. Re-arrangement is generally applied to optimize solid phase lines and thereby reduce saturated fatty acid level of the product.

Enzymatic Oil Processing: Current Status and Future Trends. M. Kellens[1], W. De Greyt[1], T. Kemper[2], J. Willits[2], [1]Desmet Ballestra Group, Zaventem, Belgium, [2]Desmet Ballestra North America, Marrietta, GA, USA

Degumming is generally recognized as a crucial process in edible oil refining with a major impact on overall processing cost and refined oil yield and quality. Hydratable phosphatides are typically removed during water-degumming which is mostly applied at the crushing plant. The wet gums can be added back to the meal or dried to lecithin as a valuable by-product. Non-hydratable phosphatides require a more severe treatment and can either be removed during alkali neutralisation (as soapstock in chemical refining) or during a separate acid degumming process (as acid gums in physical refining). The increased interest in physical refining resulted end of the 80-ties in the development of a number of new, performing acid degumming/refining processes such as the Total Degumming Process (TOP-Vandemoortele), Superdegumming and Unidegumming (Unilever), UF degumming (Krupp, Cereol). Due to a better understanding of the chemical principles of degumming, a series of new processing steps were introduced such as (a) very fine dispersion of the degumming acid, (b) partial neutralisation of the degumming acid, (c) use of two stage gums separation (TOP) and (d) cooling of the oil for better gums hydration (superdegumming). Most of these processes are still used in today?s industrial acid degumming practice. During the 90-ties, emphasis was mainly on the development of so-called ?mild? degumming processes such as first generation enzymatic degumming (Lurgi), Soft degumming (Tirtiaux) and also membrane degumming (De Smet, Cargill). For various reasons, these new processes were never broadly implemented on industrial scale. Especially the enzymatic degumming approach, although very promising, didn?t fulfil its expectations, Reason was the choice of enzyme, the higher capital and operational cost as well as the improved acid degumming alternatives. Since a few years, there is a renewed interest in enzyme assisted vegetable oil degumming which was initiated by the availability of a new series of more stable and (cost) efficient degumming enzymes from different suppliers, such as Lecitase Ultra (phospholipase A1, Novozymes), Lysomax (phospholipase A2, Danisco) and Purifine (phospholipase C, Verenium). This ?new? generation enzymatic degumming can be applied either on crude or water-degummed oils. Main driver for its implementation is not so much improved oil quality, but rather increased (crude/refined) oil yield. The latter is also the main advantage of the enzymatic lecithin deoiling. In this process, lecithin is enzymatically converted into lyso-lecithin, resulting in the release of high FFA oil. Today several industrial enzymatic degumming plants using various enzymes, working sole or combined, are in operation, and new solutions are developed to even further boost both profitability of the degumming process as well as quality of the degummed oil.

Advances in Enzyme-assisted Aqueous Extraction of Soybeans. J.M.L.N de Moura[1], N.M. de Almeida[2], S. Jung[1], L.A. Johnson[1], [1]Iowa State University, Ames, IA, USA, [2]Universidade Federal da Paraiba, Bananeiras, Paraiba, Brazil

Enzyme-assisted aqueous extraction processing (EAEP) of soybeans is an environmentally friendly technology that has the potential to replace the hazardous hexane in current oil-extraction plants. This EAEP combines extrusion, water and enzyme to fractionate soybeans into free oil, skim (protein- and sugar-rich aqueous phase), oil-rich cream emulsion and fiber. Highest oil (96%) and protein (85%) extraction yields were achieved using low solids-to-liquid ratios (SLR), 1:10, in a single-stage extraction. The use of low SLR generates high volumes of skim requiring further evaporation to recover protein and carbohydrates. The adoption of two-stage countercurrent EAEP reduced half of the usual water and improved oil and protein extractions to 99 and 96%, respectively. Oil distribution among the fractions

and cream resistance to de-emulsification were affected by moisture and conditioning temperature before flaking soybeans. In terms of extractability (oil extracted from the solids), both single and two-stage EAEP (96-99%) are as efficient as commercial hexane oil extraction (95.0-97.5%). Oil recovery, however, was only 82% (single-stage) and 78-80% (two-stage) by accounting for the unrecovered oil in the skim fraction and slightly higher resistance to de-emulsifying the cream obtained in two-stage EAEP.

Aqueous Enzymatic Extraction of Wheat Germ Oil. M. Xie, N. Dunford, C. Goad, Oklahoma State University, Stillwater, OK, USA

Wheat germ oil (WGO) is rich in vitamin E and other bioactive compounds. Commercial WGO is produced by either hexane extraction, which produces hazardous volatile organic compounds, or by mechanical pressing which has a low oil recovery. Aqueous enzymatic oil extraction process is an environmentally friendly technology that can be a viable alternative to the traditional extraction techniques. The objective of this study is to investigate the efficiency of aqueous enzymatic extraction of oil from wheat germ (WG). Four enzymes (Viscozyme L, Multifect CX 13L, Multifect CX GC and Alcalase 2.4L FG) were screened for their efficacies to extract oil from WG. Alcalase 2.4L FG which gave higher oil yield than the other enzymes was chosen for optimization of the aqueous enzymatic oil extraction process by using Response Surface Methodology. The effects of 3 processing parameters (liquid: solid ratio, extraction time and enzyme concentration) on oil extraction yield were evaluated. The highest oil extraction yield was observed when WG was treated with Alcalase 2.4L FG using Tris-HCl buffer at pH 8. However, the model developed for this system had a low R^2 (0.49). Further research should be conducted to refine experimental range within which a model can satisfactorily explain the relationship between oil extraction yield and the processing parameters, and thus maximizing the oil extraction.

Developments in Edible Oil Refining for the Production of High Quality, Contaminant-free Food Oils. W. De Greyt, Desmet Ballestra Group, Zaventem, Belgium

The vegetable oil refining process has been developed in the second half of the 19th century. It was further improved during the 20th century in order to meet better the ?standard? refined oil quality parameters: good organoleptic characteristics, light color, low FFA and long shelf life. More recently, a number of new, nutritional-quality related parameters were introduced. High quality food oils must be free of contaminants (pesticides, PAH, dioxins, heavy metals?), should contain no or very little unwanted side-products (trans fatty acids, polymers,3-MCPD esters?) and preferably have high residual concentration of natural anti-oxidants and valuable minor components (tocopherols, sterols, oryzanol?.). Recently, occurrence of 3-MCPD and glycidol esters in refined edible oils received a lot of attention and different studies are currently conducted to determine the possible ways to mitigate the formation of these unwanted minor components during the refining process. Today, the mechanism of formation of 3-MCPD and glycidol esters is however not enough understood yet and it is therefore still not fully clear how the refining process conditions can be optimized to assure mitigation of 3-MCPD and glycidol esters while maintaining the general quality and safety of the refined oil. A good understanding of the effect of the refining process conditions on refined oil quality parameters is an absolute requirement for the design of a performing refining process that meets all today?s quality objectives (good standard quality oil, max. contaminant removal and min. formation of side products).An overview will be given of different new processes that were developed, incl. active carbon treatment to reduce contaminants; dual temperature deodorization to minimize trans fatty acid formation and maximize tocopherol/sterol retention and ice condensing to achieve lower deodorizing pressures and hence a better stripping efficiency or lower thermal load.

What are the Possibilities to Reduce the Content of 3-MCPD Esters in Edible Oils?. B. Matthäus[1], A. Freudenstein[1], F. Pudel[2], J.-P. Krause[2], [1]Max Rubner-Institute, Münster, Germany, [2]Pilot Pflanzenöltechnologie Magdeburg e.V., Magdeburg, Germany

3-monochloropropane-1,2-diol fatty acid esters (3-MCPD esters) are process derived products which are formed during the refining of edible oils, especially during the production of palm oil. Since 3-MCPD esters are classified as possibly carcinogenic the German Federal Institute for Risk Assessment (BfR) stated in November 2007 that ?there is a need for immediate examination of the causes and a search for alternative techniques for the manufacture of refined fats??.Essential conditions for the formation of 3-MCPD esters are the presence of mono- and diacylglycerides or

phospholipids and chloride or chlorine as well as temperature and time. Therefore, in general three possibilities are conceivable to reduce the content of 3-MCPD esters: (1) reduction of the precursors in the raw material, (2) optimization of the refining process without deterioration of the oil quality, (3) removal of 3-MCPD esters after processing. The presentation shows some results of a research project which investigates the influence and the potential of the refining steps on the formation of 3-MCPD esters with palm oil as basis. Deodorisation is the most important step for the formation of 3-MPCD esters, but also the other steps change the amount of precursors resulting in a certain contribution to the formation of 3-MCPD esters without forming it itself during the refining step.

A Fungal Route to Produce Biodiesel from Lignocellulosics. J. (Hans) van Leeuwen[1,2], D. Mitra[2], P. Chand[2], D. Grewell[2], J. Verkade[2], V. Chintareddy[2], T.H. Kim[2], C. Ziel[2], M. Montalbo-Lomboy[2], S. Beattie[2], [1]MycoInnovations, Ames, IA, USA, [2]Iowa State University, Ames, IA, USA

Research on biofuels from lignocellulosic material has focused mainly on saccharification using various forms of physical-chemical pretreatment followed by an enzymatic process. Subsequently, the current approach is to ferment the sugars produced with yeasts. Practical considerations require much water to accomplish the saccharification, so that low concentrations of ethanol are produced. Separation of ethanol then requires more energy than would be economical. A much better route to lignocellulosic biofuels investigated by us is to produce oil after saccharification. Our group has developed a mould process that produces oil from lignocellulosic material after pretreatment. The oil is produced intracellularly and is therefore easily preconcentrated by harvesting the fungi. The fungi in question, Mucor circinelloides, grow in pellets, under the right conditions, which are easily harvested. The process developed includes hydrous ammonia pretreatment, white-rot fungal saccharification, Mucor cultication on hydrolysates, and Mucor harvesting by screening/beltpressing. Ultrasonication (20,000 Hz, 4 min) and an organic solvent can be used to extract the oil. A special catalyst developed at ISU with ultrasonication makes biodiesel production possible. The MycoFuel ™ process has been awarded an R&D 100 award in 2009.

AFTERNOON
BIO 2.1 / PRO 2.1: Processing Technologies
Chair(s): X. Xu, University of Aarhus, Denmark; and N. Dunford, Oklahoma State University, USA

Advantages and Challenges in Enzymatic Catalyzed Biodiesel Production. P.M. Nielsen, J. Brask, H. Lilbaek, M.L. Damstrup, A.R. Madsen, H.C. Holm, Novozymes, Bagsvaerd, Denmark

It is well-known that the choice of alcohol is an important factor for determining enzyme stability in a transesterification reaction. However, it further appears that enzymatic production of fatty acid ethyl ester, relative to conventional production of methyl esters, can be beneficial for both process economy, as well as from a sustainability viewpoint. The different aspects of the alcohol choice will be discussed, and the consequences of using different oil types and qualities will be illustrated.The process plant layout itself is very important for the lifetime of the enzyme and thereby the economy. A separate question is related to the enzyme product. Not only the enzyme catalyst itself but also the way it is formulated is crucial for the performance. We will discuss results from using different types of lipase, different carriers for immobilizing the enzyme, as well as the possibility of using liquid enzymes.There is not a one-fits-all solution for the enzymatic process. The enzymatic production of biodiesel will be an important opportunity for some markets with the possibility of expansion from the technology base we seek to establish for ethyl ester production into general application of enzymes with different types of oil raw materials.

Evaluation of Reaction Engineering Parameters in Enzyme-based FAEE-biodiesel Processes. M. Nordblad, Y. Xu, J.M. Woodley, Process Engineering and Technology Group, Department of Chemical and Biochemical Engineering, Technical University of Denmark, DK-2800 Lyngby, Denmark

Biodiesel is receiving increasing attention as a promising alternative to liquid fossil fuel for vehicles, being a direct replacement for petrochemical diesel. Compared to the conventional biodiesel production process, enzymatic synthesis offers several advantages such as lower reaction temperature, eliminated soap formation and simplified product recovery. Unfortunately, the cost of the enzyme-based catalysts is considerably higher than that of the alkaline

catalysts used in the conventional process. It is thus critical that the enzyme-based catalysts can be reused.The reaction conditions greatly affect the performance of enzymatic biodiesel production. For example, the concentration of alcohol in the system affects both the reaction rate and the catalyst stability. In order to maximize the amount of biodiesel that can be produced by a given amount of catalyst, it is useful to design the process to maintain controlled substrate levels. However, the production of biodiesel is a challenging process in itself, with very strict requirements on product quality for what is essentially a low-value product, and it is essential to consider this alongside the choice of operating parameters. This study presents an evaluation of the options available for the enzymatic production of biodiesel and the consequence of these for the overall design and control of the process.

Development of Reactor Technology for Improved Catalytic Productivity in Enzymatic FAEE-biodiesel Production. Y. Xu, M. Nordblad, J.M. Woodley, Process Engineering and Technology Group, Department of Chemical and Biochemical Engineering, Technical University of Denmark, DK-2800 Lyngby, Denmark

Biodiesel production catalyzed by immobilized lipases is attracting considerable interest as an alternative to conventional base-catalysed biodiesel production due to its potential of improved sustainability[1]. However, the high cost of the immobilized lipases has limited commercial application. High process efficiency could be the key to achieving high productivities of the expensive immobilized lipases and improved economic viability for large industrial application; the reactor is the core of an efficient process design. This work has taken the stirred tank reactor and the packed bed reactor as examples of reactor technology development in order to improve the productivities of the immobilized lipases for FAEE-biodiesel production.One of the major factors causing insufficient stability of immobilized lipases is glycerol, the major by-product of biodiesel production[2]. A dyeing method for indicating glycerol partitioning has been developed and applied in stirred tank and packed bed reactors to assist the reactor evaluation and its effect on catalyst productivity. The mechanical stability of the immobilized lipases has also been evaluated in these reactors. [1] Nielsen, P.M. et al., 2008. Eur. J. Lipid Sci. Technol., 110, 692. [2] Dossat, V. et al., 1999. Enzyme Microb. Technol., 25, 194.

Enzymatic Biodiesel, Monitoring and Analysis of the Reaction. Sergey N. Fedosov, Xuebing Xu, Agrobiology Group, Dept. Molecular Biology, Århus University, Århus, Denmark

Biodiesel (BD) is produced by treatment of vegetable oil with alcohol in the presence of a catalyst. Application of the enzyme lipase for this purpose is presently debated, because the enzyme has low sensitivity to oil composition and produces minimum waste. Optimization of the complex reaction kinetics is, however, required. Multiple measurements make the well established analytical methods of gas-chromatography, HPLC and TLC-FID inconvenient in terms of time, labor and expenses. The current work describes two suitable analytical approaches. First of them is a low-cost method, where the major components of reaction (BD, tri/di/mono-glycerides, fatty acids) are separated on a standard TLC plate and stained. Absence of background in the suggested procedure simplifies quantification by densitometry or visual assessment. The second method is based on measurements of fluorescent signal from a probe sensitive to polarity of the environment. This approach is useful when investigating partial reactions accompanied by a change of polarity (e.g. MG + MeOH → BD + G). Fluorescent method requires calibration of the signal and is convenient if repeated measurements are carried out. Examples of the calibration curves and the reaction records are presented. Analysis of partial reactions is discussed as an approach to simplify reconstruction of the global scheme of BD-synthesis.

Predictive Studies on Phase Equilibria of Enzymatic Biodiesel Production. G. Güzel, X. Xu, Aarhus University, Department of Molecular Biology, Aarhus, Denmark

γi,

Synthesis of Diacylglycerols: Lipases vs. Macroreticular Strongly Acidic Cation Exchange Resins. O.M. Lai[1,2], S.K. Lo[3], [1]Universiti Putra Malaysia, Serdang, Selangor, Malaysia, [2]Institute of Bioscience, Serdang, Selangor, Malaysia, [3]Sime Darby Research Centre, Banting, Selangor, Malaysia

Much has been published about the use of lipases for the production of structured lipids such as diacylglycerols. We

now report of a chemical catalyst for the synthesis of of dietary 1,3(2)-diacylglycerol. Lipases and macroreticular strongly acidic cation exchange resin were used to catalyze the esterification of stearic and oleic acids with glycerol to synthesize 1-stearoyl-3(2)-oleoyl glycerol. A dual response surface approach was used to optimize both the esterification reaction variables and the optimized conditions for both the catalysts were compared and reported.

Enzyme-Catalyzed Production of Structured Lipids under High-Pressure Conditions. S. Ferreira-Dias[1], N.M. Osório[2,1], C. Tecelão[3,1], V. Perrier[4], E. Dubreucq[4], M.H. Ribeiro[5], [1]Instituto Superior de Agronomia, Technical University of Lisbon, CEER, Lisbon, Portugal, [2]Instituto Piaget, Núcleo de Investigação em Engª Alimentar e Biotecnologia, ISEIT de Almada, 2800-305 Almada, Portugal, [3]Escola Superior de Turismo e Tecnologia do Mar, Instituto Politécnico de Leiria, 2520-641 Peniche, Portugal, [4]Montpellier SupAgro, UMR 1208 IATE, F-34060 Montpellier cedex, France, [5]Faculdade de Farmácia, Research Institute for Medicines and Pharmaceutical Sciences (i-Med.UL), University of Lisbon, 1649-003 Lisbon, Portugal

AM 2/PRO 2: Food/Feed Safety and Quality
Chair(s): M. McCutcheon, West Virginia Dept of Agriculture, USA; and J. Willits, Desmet Ballestra North America Inc., USA, and M. Snow, Bunge North America Inc., USA

Salmonella Prevention in Oilseed Meals. T. Kemper, Desmet Ballestra North America, Inc., Marietta, GA, USA

Salmonella enterica is a bacterium which can grow in reduced oxygen environments. This bacterium often exists and multiplies in the intestinal tract of birds and mammals. Bird stool in particular can come into contact with oilseeds and oilseed meals during processing and transport, thereby transfering the bacterium to these oilseed products. Recent measurement and detection of positive presence of salmonella enterica in oilseed meals has created feed quality concerns, and led to global import-export problems with oilseed meals. This paper will discuss where salmonella enterica generally enters the oilseed crushing process, how its multiplication can be minimized, and how it can be thermally destroyed. A list of key recommendations will be provided for prevention of salmonella enterica presence in oilseed meal.

Deodorization as a Driver for Product Quality. Dennis Otten, Cargill Inc., USA

General discussion on the effects of deodorization on product quality. Presentation will include deodorizer effects on pesticides, PHA?s, allergens, heating fluids, trans fatty acids, comingling, etc.

Safe Feed/Safe Food and International Trade. Keith Epperson, American Feed Industry Association, USA

TUESDAY

AFTERNOON
PRO 3 / EXH 2: Exhibitor Presentations
Chair(s): T. Neuman, GEA Westfalia Separator Inc., USA; and J. Piazza, Alfa Laval Inc., USA

Seeds and Grain Pre-Heating, Conditioning and Drying - Flexible Operation and Waste Heat Recovery. F. Salaria, Solex Thermal Science, Calgary, AB, Canada

Different seed crushing processes require seed pre-heating, conditioning and drying in one or multiple steps. The use of plate heat exchanger technology allows great flexibility for these steps allowing plants to process different seeds and adjust temperature and moisture over a wide range. The technology also adapts to cooling of seed or meal. The

technology utilises indirect heat transfer for heating and evaporation with combination of nominal volumes of cross flow air for moisture removal. The units consist of multiple banks. These heat transfer banks can be configured for flexible operation. The banks can provide pre-heating or drying as may be required. This is accomplished by switching between various heat transfer media like hot water or steam. . The total heat transfer to the seed can be very easily and precisely adjusted. The technology also offers uniform heat transfer to the seed bed . The temperature profile of seed across the bed can be accurately thermally modelled to predict outlet conditions. The amount of cross flow air can be regulated to attain various levels of moisture removal.The technology also allows great opportunity to utilise waste heat from the plant for preheating or conditioning. The preheat step can be easily incorporated with the dryer /conditioner .

Phospholipase C Enzymatic Degumming: A New Technology for Oil Refining. T. Hitchman, Verenium Corporation,, San Diego, CA, USA

Purifine® PLC is a unique enzyme product for application in the degumming step of edible and industrial oils processing. Use of Purifine® PLC results in increased oil yield, enhanced processing efficiency and other benefits. The product works by breaking down phospholipid impurities that are normally removed in the heavy phase during degumming. As a result neutral oil normally entrained in the gum is released and available for recovery. Furthermore, Purifine® PLC is unique in that it converts the phospholipid impurities into diacylglycerol (DAG), which is equivalent to neutral oil and provides additional oil yield. In total, neutral oil + DAG benefits are proportional to the phosphorus content of the oil, reaching 2% yield gains in case of crude soybean oil with 1000 ppm phosphorus. Industrial scale implementation requires a minimal modification of most existing plant layouts. Use of the Purifine® PLC product results in a low phosphorus degummed oil that is easily refined for edible or biodiesel end uses.

Semi-Continuous Deodorization: New Design Featuring Enhanced Heat Recovery and Stripping Efficacy. W. Younggreen, S. Balchen, Alfa Laval Copenhagen A/S, Denmark

Abstract forthcoming

Purification of Glycerin from Biodiesel Plants. P. Alasti, Artisan Industries Inc., USA

With the expected growth of biodiesel in the United States, as emphasized by President Obama during his Presidential campaign, we can expect a glut of crude glycerin in the coming years, as more biodiesel plants come on stream and existing plants will begin to ramp up production. Refining the glycerin to various purities will be instrumental in insuring profitability regardless of feedstock and energy costs. We will present Artisan?s refining process and compare it with two alternate processes currently available in the market.

Advances in Distillation and Solvent recovery Equipment and Processes. Adolfo Subieta, Desmet Ballestra North America, USA

The need for energy conservation is always present in solvent extraction plants. At the same time finding new creative ways of reducing operating costs is desirable. New designs in distillation equipment introduced by Desmet Ballestra North America help to lower oil temperatures while improving performance parameters. Moreover, existing processes such as DT vapor scrubbing, mineral oil hexane recovering and others have been analyzed in order to achieve savings in maintenance and operating costs.

Chemical Refining of Oils in Solvent Phase. T. Neuman, GEA Westfalia Separator Inc., USA

Process Photometry—Using Filtered Light Waves to Identify Change for In-line Conditional Process Control. Tom Schwalbach, optek-Danulat, Inc., USA

The presentation will consist of a description of the science involved in the Optek Photometric Sensor capabilities for

chemical and edible oil process applications. We will discuss the utilization of light absorption, color absorption and scattered light technology for the Edible oil industry, and a how we have adapted the science to a rugged industrial process installations for application of the science. Common Optek Edible Oil applications installed and proven successful are: oil in water, water in oil, turbidity in oil or tallow, chlorophyll to less than 10ppb, Lovibond Red, and bleaching clay applications. The industries served by Optek-Danulat, Inc. are the following: food, edible oil, sweeteners, dairy, beverage, petroleum, chemical, biotech, pulp and paper, wastewater, water, power plants, biofuels, fermentation, blood sciences, automotive, chlorine chemistry, semiconductor, metals, and mining.

Canola and Sunflower Seed Crushing: Development and Best Practice. H. Boeck, Harburg-Freudenberger Maschinenbau GmbH, Hamburg, Germany

The production of rapeseed/canola and of sunflower seed has increased substantially over the past decades. The processing plants have adapted their technologies to the needs in terms of processing capacity as well as efficiency with the help of the leading equipment suppliers. High degree of availability, low operating cost and high oil yields are key characteristics of a modern processing facility.

What's New in Buhler Preparation Equipment. C. Brockmeyer, Buhler, Inc., Plymouth, MN, USA

Buhler Inc., a worldwide company celebrating it's 150th year anniversary, has been a leader in the Grain Handling Industry since 1860, they continue to put new technologies into the Oil Processing Market:- October 2009 Buhler announced the launch of a new high capacity Flaking Mill for the Oil Seeds Industry. The new big flaker, OLFB, compliments our high capacity Cracking Mill the OLCB. - Buhler designs 2 new large models of Fluidbed Drier OLHA for the hot dehulling of soybeans. - Buhler has upgraded its dehulling and conditioning equipment with DIRO and ATMAWe now promote a full line of preparation equipment along with advanced technology, automation and customer service.

WEDNESDAY

MORNING
PRO 4: Personnel and Facility Safety
Chair(s): T. Gum, Agribusiness & Water Tech Inc., USA; and P. Pham, University of Mississippi, USA

Facility Security and Food Defense Planning. R. Ryan, Archer Daniels Midland Company, Decatur, IL, USA

Food Defense was the topic of the first conference held at the Terrorist Threat Integration Center (TTIC), now known as the National Counter-Terrorism Center (NCTC). It is the subject of a Homeland Security Presidential Directive (HSPD-9), and has been the focus of hundreds of meetings, discussions, and projects since 2001?and now regulation. It is vitally important that industry understands the process and implications associated with food defense risk assessment, gap analysis, and food defense planning. The failure to understand the importance of accurate risk assessment and the relationship between food defense planning and facility security can result in wasteful spending and, more importantly, leave enterprise level risks unaddressed.

Challenges in Complying with Both Construction and Site Specific Safely Polices. Brent Kooiman, Interstates Engineering, USA

In this presentation we will explore the challenges and lessons learned from the construction industry as it has dealt with site specific safety policies. The construction industry deals with changing requirements at each site that they work at, has people continually transferring in and out of the site and has more exposure to certain types of hazards and yet continues to improve in overall safety. What can we learn from them? This presentation will explore these questions and some of the underlying principles for a good safety program.

Planning for a Pandemic. W. Minor, Ventura Foods, LLC, Brea, CA, USA

According to various studies, flu pandemics occur every 20-30 years. The most infamous 20th century flu pandemic - the Spanish Flu - occurred in 1918, at the end of World War I. The 1918 flu was spread by soldiers returning home - then, by land and sea. Today, however, modern advancements in affordable transportation have escalated the speed, distance and frequency at which infectious diseases spread, thereby increasing the probability of a pandemic. The world has anticipated the development of avian influenza (H5N1) as the next highly pathogenic pandemic. Fortunately, sustained human-to-human transmission of H5H1 influenza has not yet materialized.While the world was watching for a H5N1 pandemic, a H1N1 epidemic began in Mexico in April 2009. This epidemic spread rapidly and the World Health Organization (WHO) declared a Phase 6 Pandemic on June 11, 2009. To this point, this novel AH1N1 influenza has proven no more severe or contagious than seasonal flu. Again, the world is fortunate, so far. Experts agree that the emergence of a highly virulent pandemic is a matter of ?when?, not ?if?. World Bank simulations of a severe case scenario project economic costs of a pandemic to be on the order of $1.2 trillion to $2 trillion. Because a pandemic is predicted to occur in waves, the following effects may ensue for up to two years:Absenteeism - A pandemic could affect as many as 40 percent of the workforce during periods of peak influenza illness.Change in patterns of commerce - During a pandemic, consumer product selection, demand, and the ways in which people shop may change in an effort to reduce person-to-person contact. Interrupted supply/delivery - Shipments of items from geographic areas severely affected by the pandemic may be delayed or cancelled. Absenteeism in the transportation industry and support industries may affect supply movement in general.It is essential that business entities assess the threats that a serious pandemic would pose to their customers, employees and businesses and develop plans to mitigate the adverse impacts. The elements of a sound pandemic plan include:Supply Chain ? vendor capabilities, vendor plans, and alternate suppliersManufacturing ? multiple sites, co-packing arrangements Workforce ? chain of command, cross-training for key positions, work-from-home, employee awareness and protection, personnel policiesFinancial PlanningCommunity and Government Liaison All pandemic plans should be continuously modified to reflect changing conditions.

Creating a Corridor of Care for Injured Workers. M. Boulton, Travelers Insurance, Hartford, CT, USA

When a workplace injury occurs, having a well defined response process can make a significant difference in the outcome for the employee, his or her supervisor, and the employer. This session discusses how to establish a concise ? Corridor of Care? that defines the proper procedures, responsibilities and controls to integrate to minimize organizational disruptions and contain injury claim costs.

AFTERNOON
PRO 5: General Processing
Chair(s): G. Hatfield, Bunge Canada, Canada; and M. Noble, Lake Erie Biofuels LLC, USA

Quality Differences between Pressed and Solvent Extracted Vegetable Oils. R. Verhe[1], V. Van Hoed[1], C. Ben Ali[1,2], M. Slah[2], [1]Ghent University, Ghent, Belgium, [2]University 7th November of Carthage, Tunis, Tunisia

The interest to avoid chemical contamination explains a consumer preference for pressed over solvent extracted vegetable oils. Pressed oil is moreover expected to contain more nutritionally valuable compounds, which can in turn enhance the oxidative stability of the oil. However reports on differences between extracted and pressed oils are scarce. Therefore in this study, the composition and quality was systematically compared for a corn and a rapeseed oil, between the pressed oil and the oil extracted with hexane from the press cake. Their composition and quality parameters were monitored after each refining step. In the extracted oil, solvent residues were detected, which caused a clear sensory difference, but were removed almost completely during refining. The crude oils had a high content in free fatty acids and in primary and secondary oxidation products, which were higher in the extracted than in the pressed oils. However, surprisingly, also the content of minor compounds was slightly higher in the extracted oils than in the pressed oils. This can be explained by a selective extraction of those compounds into the solvent. During refining, a difference between pressed and extracted oils persisted but became less pronounced. The slight difference in antioxidants content might explain the higher oxidative stability of both extracted oils.

Optimization of Enzyme Efficiency through Control of Oil Quality Used in Interesterification. W.D. Cowan[1],

H.S. Yee[2], H.C. Holm[3], H.M.L. Pedersen[3], [1]Novozymes UK, Chesham, Bucks, UK, [2]Novozymes Malaysia, Kuala Lumpur, Malaysia, [3]Novozymes Denmark, Bagsvaerd, Denmark

Enzymatic interesterification is widely used for the production of trans free hardstocks by the edible oil industry. Recent research has demonstrated the oil quality parameters that need to be controlled in order to have a high enzyme productivity. Some of these parameters are difficult to control if the oils are sourced externally.This paper discusses recent research into simple and practical methods that can be applied prior to interesterification to increase oil quality and hence maximise enzyme utilisation. The paper will also discuss some case histories of the application of these methods at plant scale.

The Shape-Selective Hydrogenation of FAMEs and Vegetable Oils. A. Philippaerts, S. Paulussen, B. Sels, P. Jacobs, KU Leuven, Leuven, Belgium

Ethanolic Extraction of Rape- Seed Meal. Current Results and Prospective Outlook using this New Process. G. Börner[1], W. Paul[2], G. Fleck [2], [1]ÖHMI Engineering, Germany, [2]PPM e.V. Magdeburg, Germany

Rape seed extraction meal (REM) has got a growing importance and interest in use as an animal feed - resulting from increased processing of rape seed. An improved quality of REM can extend its application for different kinds of animal feed and can contribute to a much better economical result of the whole rape seed crushing process.In the current situation, the use of REM as animal feed is limited because of still significant levels of anti- nutritive substances in the meal, mostly glucosinolates and in addition, a higher content of protein with better functionality is essentially required.Process applications forming an extension of existing running crushing plants are described in each single process step, which will be explained in their main tasks, achieved results and their combination with each other.Summarizing the achieved research results an outlook will be given for future implementation into industrial scale for both, the new production process as well as for new high-quality REM.

Fractionation of Short and Medium Chain Fatty Acid Ethyl Esters from a Blend of Oils via Ethanolysis and Short-Path Distillation. L. Vázquez, C. C. Akoh, University of Georgia, Athens, Georgia, USA

The main objective of the present work was to obtain fractions enriched in short (SCFAEE) and medium chain (MCFAEE) fatty acid ethyl esters (FAEE). For this purpose, coconut oil and dairy fat were blended and a transesterification of this blend was effected in order to transform the triacylglycerols into their corresponding FAEE. A detailed study of fractionation conditions for FAEE was carried out using short-path distillation. Different conditions were explored such as feed rates and temperatures; operating conditions, such as successive steps or a single step. The composition and yield of SCFAEE and MCFAEE were determined at different distillation conditions. Optimal fractionation of desired compounds was achieved. Good relationship between purity and yield of SCFAEE and MCFAEE was established for this process. A broad range of high value fractions were obtained depending on conditions selected. The fractions we obtained can be used as starting materials for the production of functional lipids.

Jet-based Dehulling and Conditioning of Seeds in a Fluidized Bed Process. M. Börner[1], M. Peglow[1], M. Henneberg[2], G. Börner[3], [1]Otto-von-Guericke-University, Magdeburg, Germany, [2]AVA - Anhaltinische Verfahrens- und Anlagentechnik GmbH, Magdeburg, Germany, [3]ÖHMI Engineering, Magdeburg, Germany

In the processing of seeds the preparation constitutes an important process step for improving the yield and quality of a product. In a novel treatment process three preparation processes comprising dehulling, drying and conditioning are combined using a continuous multi-stage fluidized bed. Hereby, the fluidized bed is divided into several stages for different preparation processes. In the first stage the previously broken seeds are dehulled by using warm fluidization air. Clinging and hooked hulls are removed completely by an additional gas stream generated by nozzles. In the same stage the seed is heated up and dried to required moisture content. In the second stage of the fluidized bed a final heating and drying takes place. In energy regeneration the warm moist outlet air from stage one can be reused in stage

two. Subsequent to the fluidized bed the grain can be processed in a much smaller conditioner unit. In this study the basics of the novel treatment process are experimentally investigated for soybeans. In comparison to conventional processes the number of necessary apparatuses is reduced with a considerable decrease in investment costs. The operating costs are reduced by applying energy regeneration of the warm outlet air. Summing up, a novel process is hereby established for a more effective and cost-saving pre-treatment of seeds.

Mechanisms of Aqueous Extraction of Extruded Sunflower Meal. Kerry A. Campbell[1], Pierre-Yves Pontallier[2], Charles E. Glatz[1], [1]Department of Chemical and Biological Engineering, Iowa State University, USA, [2]Laboratoire de Chimie Agro-Industrielle, Ecole Nationale Supérieure des Ingénieurs en Arts Chimiques Et Technologiques, France

Aqueous extraction processing (AEP) with and without enzymes was studied to improve vegetable oil extraction yields of extruded sunflower meal without the use of hazardous organic solvents. Microscopic observation of sunflower meal before and after AEP indicated extensive cellular disruption was achieved by extrusion, but unextracted oil remained sequestered as coalesced oil within the cell wall confines of disrupted cotyledon cells, as well as within the void spaces of sclerenchyma cells of the pericarp. A full factorial design experiment showed that agitation and cellulases increased oil extraction yield, indicating emulsification and alteration of the confining cellular matrix were important mechanisms for improving yields. Protease and solid-liquid ratio did not have significant effects, indicating key differences with previously established mechanisms for soy oil extraction. It is hypothesized that this is because of differences in the nature of the proteins present as well as the geometry of the confining cellular matrices.

Reducing the Global Warming Potential of Margarines. R.M.M. Diks, G. van Duijn, Unilever, Vlaardingen, Netherlands

The reduction of the environmental impact of activities and products is of increasing importance in society. Unilever has recognised this and we initiated an assessment of this impact for major products, i.e. a so-called Life Cycle Assessment. An important class of products are margarines and fat based spreads. Margarines are basically a fat continuous product consisting of a water-in-oil emulsion that is stabilized by a structure of solid fat. The liquid oil is generally derived from sunflower, rape or soy, whereas the solid fat is nowadays mostly coming from palm oil derived hardstocks.In this presentation the results from this assessment will be presented, focussing on the impact of the products carbon footprint also referred to as Global Warming Potential (GWP). The various stages of the supply chain, from tree to tub, will be looked at and potential saving areas will be discussed. This includes the agricultural part, oil milling, transport, refining, product manufacturing and packaging.It will be shown that the major impact on GWP comes from the production of oil crops. As these crops are traded as commodities, improvements can only be achieved by close collaboration of the complete supply chain. For palm oil this is realized though the Round Table for Sustainable Palm Oil (RSPO).

Processing Posters

Chair(s): V. Jain, Oil-Dri Corp of America, USA

Chemical Composition of Jatropha cordata (Ort.) Muell. Arg. and Jatropha cardiophylla (Torr.) Muell. Arg. Seeds from Northwest of Mexico.

L.A. Medina-Juárez[1], E. Gil-Montaño [2], P.P. Alday-Lara [3], L. Bringas-Alvarado [1], N. Gámez-Meza[1], [1]Departamento de Investigaciones Científicas y Tecnológicas de la Universidad de Sonora, Hermosillo, Sonora, Mexico, [2]División de Ciencias Biológicas de la Universidad de la Sierra, Carretera Moctezuma-Cumpas Km 2.5, Moctezuma, Sonora Mexico, [3]Posgrado en Biociencias de la Universidad de Sonora, Hermosillo, Sonora, Mexico

Jatropha curcas oil has been a growing interest as a feedstock for biodiesel production, because this oil is not used as food. This specie is a perennial plant, native and widely spread throughout many tropical countries. However, in Northwestern of Mexico there are other species of *Jatropha* (*J. cordata* and *J. cardiophylla*) adapted to arid and semi-

arid conditions (≤ 500 mm, precipitation; 8°C a 45°C temperature). The aim of this study was evaluate the potential of *J. cordata* (JC) and *J. cardiophylla* (JCph) seeds as sources of protein and oil. The meal and oil from JC and JCph seeds were characterized chemically. The results show that, the JC and JCph seeds were rich in crude protein (23.32 ± 1.9 – 25.75 ± 0.4 %) and lipid (around 39.76 ± 0.77 %). The fatty acids found in the oil from JC and LCph seeds were linoleic (49.88 – 50.72%), oleic (36.60 – 34.36%), palmitic (7.66 – 8.03%) and stearic (4.16 – 5.41%) acids respectively. We also found palmitoleic (1.35 – 1.05%) and araquidonic (0.09 – 0.18%) acids respectively. Oils from JC and JCph seeds were converted to biodiesel using the traditional transesterification method and sodium hydroxide in methanol was used as catalyst. The transesterification efficiency was measured by gas chromatography.

Optimization of Camelina Sativa Oil Deodorization.

R. Hrastar[1], L.Z. Cheong[2], X. Xu[2], I.J. Kosir[1], [1]Slovenian Institute of Hop Research and Brewing, Cesta Zalskega tabora 2, 3310 Zalec, Slovenia, [2]University of Aarhus, Department of Molecular Biology, Gustav Wieds Vej 10, DK-8000 Aarhus C, Denmark

Camelina sativa oilseed crop is a member of the Brassicaceae family with common names like false flax, gold of pleasure or leindotter. The main product of Camelina sativa is the oil, which is characterized for its high content (up to 40 wt. %) of essential α-linolenic acid (C18:3n-3) and specific flavour. Camelina oil can be an alternative edible oil for food uses, and, therefore, a deodorization study of this beneficial oil is a prerequisite as no studies have been done before. Optimization of bench-scale deodorization of camelina oil via response surface methodology is presented in this study. Three factors (temperature, time, steam) were included, while pressure was kept constant. Results demonstrate that deodorization at temperatures up to 210 °C provides oil of excellent quality, while temperatures at 225 °C and above have negative impact on sensory performance and amount of trans fatty acids formation. Data on the camelina oil deodorization procedure via response surface methodology provide a basis for the further investigation on pilot- and industrial-scale deodorization.

Quantification of Free Sterols and Steryl Glucosides in Soybean Oils from Different Stages of Seed Preparation.

M.V. Ruiz-Méndez, M.R. Aguirre-Gonzalez, Instituto de la Grasa.CSIC, Seville, SPAIN

Soybean oil is widely used to manufacture biodiesel. Compounds such as sterol derivatives pass to oil during the extraction process and are retained in the biodiesel, causing precipitation and filtration problems. This paper presents the results obtained in the quantification of free sterols, and steryl glucosides in oils obtained from seeds after different stages of preparation (initial seeds, flakes and pellets). Samples were extracted with hexane and the residual oil was then extracted with a mixture of chloroform-methanol. The evaluation of the sterol compounds was performed by high temperature GC directly in the sylanized unsaponifiable matter using cholestanol as internal standard.The results indicate a better accessibility of the non-polar solvent to the oil as the process of seed preparation proceeds. Thus, the oil obtained from the initial seed was 16,4 %, whereas 17.5 % and 21 % were obtained from flakes and pellets, respectively. The free sterol content was close to 5000 mg/kg oil in all the samples while the content of steryl glucosides was variable and lower than 200 mg/kg. In contrast, the residual oil extracted with the polar mixture ranged between 6% in the initial seed and 3.5% in the defatted pellets with a content of sterol glycosides higher than 1 % and very low content of free sterols

Harvesting of Micro-algae for Low Value Applications: the Possibilities of Flocculation.

D. Vandamme, I. Foubert, K. Muylaert, K.U.Leuven Campus Kortrijk, Kortrijk, Belgium

Due to their small size and low concentration in the culture medium, cost efficient harvesting of microalgae for low value applications (e.g. biodiesel production) is a major challenge. Harvesting microalgae by flocculation could reduce production costs when compared to harvesting by centrifugation. Biodegradable organic flocculants, such as cationic starch, do not contaminate the algal biomass and are often required in lower doses than commonly used inorganic flocculants. We evaluated the potential of cationic starch as a flocculant for harvesting microalgae using jar test experiments. For flocculation of Parachlorella, the cationic starch to algal biomass ratio required to flocculate 80% of algal biomass was 0.1. For Scenedesmus, a lower dose was required: ratio 0.03. The flocculation was independent of pH between 5 and 10. Measurements of the maximum quantum yield of PSII suggest that the cationic starch was not toxic to Parachlorella. No flocculation of marine species could be achieved.Cationic starch may thus be used as an

efficient, cost-effective, and widely available flocculant for harvesting microalgal biomass. In additional experiments, more freshwater species will be tested. Moreover, N and P depletion, hydrodynamic properties and floc density and strength will be evaluated in order to optimize the flocculation efficiency.

Minor Compounds Extractability of Sunflower Oil in Packed Bed Extractor.
M.C. Cingolani, M.E. Carrin, A.A. Carrelli, PLAPIQUI (UNS-CONICET), Bahía Blanca, Buenos Aires, Argentina

During solvent extraction of seed oil, oil composition changes from almost pure triglycerides to fractions containing no glyceride material of low solubility. Tocopherols and phospholipids are natural compounds of oil seed that pass to the oil during extraction. Temperature, time, amount of solvent, and other parameters of extraction influences yield and composition of obtained oil. The aim of this work is to study the effect of raw material pretreatment (expanded collets and press cakes) and temperature (50-60ºC) on the extractability of minor compounds (phospholipids and tocopherols) during sunflower oil extraction using a laboratory packed bed extractor.Sunflower oil was extracted from the raw material in a packed bed extractor at pilot scale, using commercial hexane as solvent. Tocopherols and phospholipids content determinations were performed by HPLC. Tocopherol and phospholipid compounds were extracted in a similar manner as oil. Results showed that temperature had the most significant effect over extraction kinetic. Analytical data would be useful in future modeling studies and simulation applications.

Catalyst Removal Following CLA Production by Soy Oil Linoleic Acid Isomerization.
Brooke Henbest, Andrew Proctor, University of Arkansas, Fayetteville, AR, USA

Dietary conjugated linoleic acid (CLA) is well recognized for its anti-carcinogenic, anti-atherogenic properties and ability to increase lean body mass and protect against immune induced body wasting disease, chronic inflammatory diseases, cancer and its other positive health effects. Dairy products and beef are the primary source of CLA from ruminant fermentation of dietary linoleic acid (LA) with levels of 0.12% and 0.03% found in beef and milk, respectively. However, the current human intake of CLA is 10 times less than the 3g/day minimum value proposed to have optimal human benefit, as extrapolated from animal studies. Obtaining these levels of CLA from beef and dairy products would increase the total fat and saturated fat intake and increase the negative health risks associated with dietary animal fats. The production of a more concentrated CLA source in a readily available food with minimal saturated fat would therefore be beneficial. We have produced a pilot plant technology to photoisomerize soy oil linoleic acid in soy oil using an iodine catalyst, to obtain a 20% CLA oil. The objective of this research was to develop a rapid practical means of removing iodine from the oil after processing. We investigated aqueous potassium iodide partitioning and magnesium silicate adsorbents in the form of Magnesol and Florisil as means of iodine removal from the oil after processing in a batch system. Our results showed that partitioning was not as effective at removing large quantities of iodine as Florisil. Magnesol was also less effective than Florisil at adsorbing iodine from the oil. Therefore, consecutive treatments of Florisil adsorbent is probably the most efficient processing procedure. These results suggest that production of a food quality high CLA vegetable oil is possible by adsorptive removal of catalytic iodine.

Optimization of Oil Recovery from Viscera of Indian Mackerel (Rastrelliger kanagurta) Using Supercritical Fluid Extraction Techniques.
Sahena F., Zaidul I.S.M, Jinap S., Karim M.R., Akanda M.J.H, University Putra Malaysia, 43400, Selangor, Malaysia

Fish viscera are a major waste of fish process industry that can be exploited as a good source of poly unsaturated fatty acids (PUFA). Viscera from Indian Mackerel (Rastrelliger kanagurta), an abundant fish species in Malaysia, was chosen as a sample for oil recovery by various methods of supercritical fluid extraction (SFE) e.g. continuous, co-solvent, soaking, and pressure swing techniques. The SFE parameters of pressure, temperature and CO2 flow rate were varied from 20 to 35 MPa, 45 to 75 oC and 1 to 3 ml min-1, respectively and were optimised by employing Response Surface Methodology (RSM) with a view to maximize the oil yield and minimize CO2 consumption. The central composite rotatable design (CCRD) consisting of three variables provided 20 experimental settings. Multiple regression was used to estimate the coefficients of the second-order polynomial equation. The optimum parameters for all of the techniques applied were found to be 35 MPa, 60 oC, and 2 ml min-1. The visceral oil was recovered from 93 to 99% for the four various SFE techniques applied. The yields were compared with the traditional solvent extraction method.

Supercritical CO2 Extraction of Lipids and Other Valuable Products from Microalgae.

M. Danthurebandara[1], K. Goiris[2,1], K. Muylaert[1], L. De Cooman[2], I. Foubert[1], [1]K.U.Leuven Campus Kortrijk, Kortrijk, Belgium, [2]KaHo Sint-Lieven, Gent, Belgium

In the quest for sustainable commercial production of bioproducts such as lipids, pigments and proteins and for pollution mitigation and CO2 abatement, microalgae are increasingly receiving attention due to their high growth rate, high CO2 sequestration and their lack of requirement for fertile soil surface compared to conventional crops. Because microalgal biomass consists of individual cells with rigid cell walls, extraction of useful components from the biomass is often problematic. Extraction and processing with supercritical fluids (SCF) is increasingly gaining importance in the food, pharmaceutical and chemical industries and can be a solution for these specific problems. Carbon dioxide is the most common supercritical fluid. The goal of this work was to investigate the possibility of using supercritical carbon dioxide extraction to obtain the lipids and other valuable products from microalgae. The supercritical fluid extractions were carried out at different temperatures, pressures as well as with different extraction times and carbon dioxide flow rates. Both the lipid yield and composition were considered in order to optimize the supercritical carbon dioxide extraction and to compare its efficiency with the conventional extraction methods.

Dehulling of Lesquerella Seeds for the Production of Gums and Oil.

R. Evangelista, R. Harry O'kuru, USDA, ARS, NCAUR, Peoria, IL, USA

Lesquerella (Lesquerella fendleri), an oilseed crop native to the southwestern United States, is being developed as an alternative source of hydroxy fatty acid (HFA). HFA is used in industrial applications such as lubricants, plastics, emulsifiers, and coatings. The seed coat contains a natural gum which is useful as viscosity modifier. The gum had been recovered by aqueous extraction from whole seed, defatted meal, and seed coat (hulls). This study evaluated the effectiveness of milling and density-grading as a method of separating the hulls and cotyledons of lesquerella seeds. Seeds were dehulled using an impact mill and fractionated using 22- and 24- mesh screens. Upon density-grading, 20% of the middle fraction (56% of starting material) was recovered as hull-rich fraction (HRF) with about 90 to 97% hulls and containing 5.8 to 11% oil. The cotyledon-rich fraction (CRF) had an oil content of 30-34%. The starting whole seed, hand-picked cotyledons, and hand-picked hulls had oil contents of 28.0, 52.8, and 4.2%, respectively. The viscosity of aqueous dispersion with 1% gum ranged from 1,265 to 3,150 centipoise (cP), which exceeded the minimum viscosity requirement of 1,000 cP for similar products. The color of the oil extracted from CRF was lighter (13 Gardner) than the oil from whole seed (14.8 Gardner).

Obtention of High Micro-nutrients Content Oils for Food and Non-food Uses.

X. Pages[1], M. Gaud[1], C. Alfos[1], A. Rossignol Castera[1], P. Carre[2], [1]ITERG, Pessac, France, [2]CREOL, Pessac, France

Mild ways of processing oilseeds have been developed in order to provide mild refined oils for both food and non food applications.This work has been done by ITERG and CREOL in the framework of two European collective research programs: OPTIMOILS : valorization of healthy lipidic micro-nutrients by optimizing food processing of edible oils and fats and IBIOLAB: Improvement of Biolubricants Manufacturing and Development thanks to the Obtaining of EcoLabel.For food application, the interest of micro-nutrients such as sterols, tocopherols, phospholipids, phenols and co enzymes (Q9 and Q10) is certain ; new processing ways of production (mild cooking and pressing ; extrusion ,..) and mild refining have been studied. Mild-refining oils with high content of these micro-nutrients have been obtained and studied in a nutritional point of view.For non food applications and especially in lubricant applications, mild refined VHOSO (very high oleic sunflower oil) with very high oxidation stability and interesting characteristics (tribological test) has been produced and studied by industrials in different formulations of biolubricants (hydraulic fluid, two strokes engine, grease, gear oil and neat oil,).

A Bleached Oil Case Study - Unexpected Correlations between PV, AV, and OSI.

V. Jain, D. Brooks, A. Dalby, Oil-Dri Corporation of America, Chicago, IL, USA

Oxidative stability of lipids can be determined using estimators and predictors. Correlations between the analytical results and the oil stability may vary depending on the refining process and process-parameters and may need validation for each process. This case study discusses the correlation of measured oxidation quality of oil to its stability

in bleached soy and cottonseed oil. Refined soy and cottonseed oils were bleached at the dosage required to meet chlorophyll and color specifications with 15 commercially available bleaching clays obtained from several manufacturers. The bleached oils were analyzed for peroxide value (PV), anisidine value (AV), oxidative stability index (OSI), color using AOCS RY scale, and chlorophyll content. The results indicate that PV and AV (and Totox) vary with bleaching clay type. However, OSI remained unaffected by the clay parameters. A multivariate analysis showed that there is a significant correlation between AV and Totox. However, there was no significant correlation between OSI and AV, PV, and Totox. The lack of correlation suggests that higher AV?s may not result in lower oil stability in bleached oils. Anisidine value was not found to be a suitable predictor of oil stability in this case study.

In situ Alkaline-Catalyzed Transesterification 0f Ripe Mantled (Poissoni Spp) and White Ripe (Albescens) Oil Palm Fruits for Biodiesel Fuel Production: Preliminary Results.

Roland Abigor[1], Jude Obibuzor[1], Dere Okiy[1], Patrick Uadia[2], Emmanuel Okogbenin[1], [1]Biochemistry Division, Nigerian Institute for Oil Palm Research, NIFOR, Benin City, Edo State, Nigeria, [2]Department of Biochemistry, University of Benin, Uniben, Benin City, Edo State, Nigeria

Biodiesel fuels were produced from the macearated mesocarp of ripe mantled (Poissoni Spp) and white ripe (Albescens) oil palm fruits via insitu transesterification with methanol using sodium hydroxide as catalyst. The yield of the methyl esters (Biodiesel fuels) ranged from 40-57% while the purity was 98%.

Aqueous Enzyme-assisted Oil and Protein Extraction from Jatropha Curcas Kernels.

S. Latif, H.P.S. Makkar, K. Becker, Institute for Animal Production in the Tropics and Subtropics (480), Department of Aquaculture Systems and Animal Nutrition, University of Hohenheim, Stuttgart, Germany

Aqueous extraction of oils has emerged as an environment friendly extraction method, the efficiency of which can be enhanced by incorporating enzymes. Seven enzyme-mixtures designated as S, T, U, V, W, X, Y, and Z were evaluated for their effects on the extraction of oil and protein from Jatropha curcas kernels. These enzymes were employed under pre-determined set of conditions (1:10 seed/water ratio, w/w; 15:1000 enzyme/kernel weight, w/w; 45°C incubation temperature; 120 min incubation time, shaking at 500 rpm). Among the enzyme mixtures, U enzyme adjuvant showed best results, extracting 58.3% oil and 81.4% protein from the kernels. For optimum oil and protein recovery with this enzyme, the operational parameters were optimized. The conditions: 5:1000 enzyme/kernel (w/w), 7.5 pH, 45°C incubation temperature, 120 min incubation time, shaking at 500 rpm, and 1:8 seed/water ratio (w/w) were found to be optimum for maximum oil and protein extraction, extracting 89.4% oil and 90% protein from the kernels. From this, 73.8% oil was recovered and recovery of the rest (15.6%) from the emulsion and aqueous phases could possibly be enhanced by a continuous process in which these phases could be used to extract oil from a fresh batch of kernels. The characterization of oil and kernel meal obtained is in progress.

Bleaching Properties of Brazilian Natural Clays.

R.S.P. Oliveira[1], V. Mariotto[2], J.M. Block[3], D. Barrera-Arellano[1], [1]University of Campinas - UNICAMP, Campinas, SP,BRazil, [2]TECNARGILAS, Taubaté, SP, Brazil, [3]University of Santa Catarina - UFSC, Florianópolis, SC, Brazil

In processing of vegetable oils, adsorbents are used to remove the pigments and other components formed during the refining process. Activated bleaching earth is by far the most common adsorbent for purification and color improvement of fats and oils. Activated clays are normally obtained by heating for a few hours with acid, which impairs their use and disposal. Residue is usually disposed of in landfills. Different ways of activation of the clays are being studied in order to use them as fertilizer and animal feed, since they are rich in nutrients. This work aimed to study the bleaching properties of Brazilian natural clays in degummed refined soybean oil. The Tonsil Optimum 380 FF was used as a standard. Eleven samples (mixtures of attapulgite and montmorillonite from Taubaté, SP, Brazil) were used to determine the bleaching activity, filterability and oil retention. The bleaching activity results were all lower than the standard (between 2.2- 4.5 R vs 1.7 R of Tonsil). Oil retention between 16-25% for the clays and 22% for Tonsil samples were observed. Filterabilities values of 106 and 120 sec for the clay mixtures and 112 sec for Tonsil were obtained. Some mixtures of natural earth, montmorillonite and attapulgite showed bleaching properties comparable to Tonsil activated clay with the advantage that it can be used as a fertilizer or animal feed after being used as a bleaching clay.

Aqueous Enzymatic Extraction of Wheat Germ Oil.
M. Xie

Biodiesel Production from Sludge Palm Oil Using Chemical Reactor.
Adeeb Hayyan[1], Md. Zahangir Alam[1], Mohamed E.S. Mirghani[1], Nassereldeen A. Kabbashi[1], Irma Nazashida Mohd Hakimi[2], Yosri Mohd Siran[2], Shawaluddin Tahiruddin[2], [1]IIUM, Bioenvironmental Engineering Research Unit (BERU), Department of Biotechnology Engineering, Faculty of Engineering, International Islamic University, Malaysia, [2]Sime Darby, Processing & Engineering, R&D Centre, Sime Darby Research Sdn Bhd. Lot 2664 Jalan Pulau Carey, 42960 Pulau Carey, Kuala Langat, Selangor, Malaysia

Solubility of Lipids in Subcritical Propane.
D.L. Sparks, S.D. Crymble, W.E. Cherry, R. Hernandez, W.T. French, Mississippi State University, Mississippi State, MS, USA

Lipids can be used to make a variety of renewable chemicals, such as pharmaceuticals, herbicides, detergents, plasticizers, lubricants, and paints. In the process of generating lipid-based chemicals, solvents are often used to initially extract the lipid from a matrix and to help process the lipid into the desired product. The use of greener, alternative solvents such as carbon dioxide and propane in processing lipid components is being heavily researched. In terms of triglycerides, propane has been shown to have greater solvating ability at lower pressures than carbon dioxide; however, experimental solubility data for lower molecular weight lipids primarily exists only for supercritical carbon dioxide. In this research, the solubility of small-chain fatty acids, such as oleic acid and pelargonic acid, in subcritical propane has been determined over a range of temperatures and pressures and compared to the solubility observed when using carbon dioxide.

Technical Program