106th AOCS Annual Meeting and Industry Showcases

Lipid Oxidation and Quality Division Technical Program Abstracts

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LOQ 1a: Evaluation of Lipid Oxidation: Sensory

Chairs: A. Bedford, Bunge Oils Inc., USA; and M. Pietz, Archer Daniels Midland Co., USA

What to Consider when Screening Panelists. B.C. Bolton, Product Dynamics, a Division of RQA, Inc., USA.

Descriptive panels are known for their ability to accurately and consistently detect, describe, and rate the intensity of sensory attributes that are in products. The intensity ratings are critical to food and ingredient sensory evaluations, because they provide a "finger print" of the profile. However, before a panel can be trained to deliver these results, each person first must be individually screened for their inherent capability. Their inherent capability is not just limited to their taste and smell acuity, they must also be able to detect and recognize attributes among the midst of other attributes. Potential panelists must also possess specific personal attributes (e.g., willingness to participate, availability, good health, group fit, etc.). This presentation will guide you through the process of screening and give guidelines for the selection of panelists for sensory evaluations.

Key Components Essential to a Production Quality Sensory Program. S. Perry, Archer Daniels Midland Co., USA.

The objective of developing and implementing a Quality Sensory Program at the production level is to understand and monitor the sensory quality of incoming ingredients, in-process material and finished products. This enables us to consistently provide our customers with products of superior sensory quality. Key components are essential to establishing an Industry Leading Quality Sensory Program. This presentation will focus on these critical elements. An important initial goal is developing the support of cross-functional stake holders which may include Production, Sales/Business units, Quality and Sensory. Next steps would include selecting proper test methods which utilize industry scales and developing product specific references to use as anchors on those scales. Appropriate controls will need to be identified and sensory specifications set incorporating production and customer input. Finally, a procedure for panelist selection and training must be determined and performance metrics for both production and panelists developed. Examples from our Edible Oils Quality Sensory Program will illustrate how each of these components have been addressed and are being implemented across our Oil production facilities. Examples from other successful ingredient Sensory Quality Programs will be provided when appropriate.

The Value of a Sensory Quality Program to Nutritional Consumer Products. M. Godbout, Abbott Nutrition, USA.

There are many dietary and health benefits of oral nutrition-based products for the consumer; however, those benefits can only be realized if the product is consumed. Therefore, the products must taste good, meet consumer expectations and exhibit consistency in manufacture. For these reasons sensory science is valuable, if not critical, to the product development process. At various key stages within the product development life cycle, different sensory science methodologies can be employed to provide guidance. A well designed sensory program includes consumer research, the integration of that research into product development, and the capability to monitor ingredient and product quality. Throughout the development process, ingredient quality is crucial to the success of the product. The purpose of this presentation is to communicate the value of sensory science during key stages of the product development life cycle.

Oxidation and Its Effects on Quality and Sensory Attributes of Omega-3 Oils. J. Kralovec, Z. Tan, W. Zhang, and W. Indrasena, DSM Nutritional Products Canada Inc., USA.

Omega-3 oils that contain significant quantities of the metabolically active eicosapentaenoic acid and docosahexaenoic acid are very popular, especially for their effect on cardiovascular health, cognition and inflammation. However, they are highly prone to oxidation, and the nature and magnitude of the oxidation dictates the composition of the complex mixture of the volatile degradation products. The molecular structure of these volatiles determines their affinities with olfactory receptors of the membranes of olfactory neurons and therefore their sensory attributes. Correlations between the chemical composition of the volatiles and the sensory characteristics have been studied to develop predictive models with limited success. The parameters involved in these studies were the original composition of the oil, the amount of

initially trapped oxygen, the amount and type of antioxidant(s), and the presence of oxidation promoters and inhibitors. Also, the presence of certain naturally occurring compounds that are generally not picked up by the standard analyses can have an impact on the oxidation kinetics and resulting sensory attributes of the oils. Our experience, the most recent developments in oxidation monitoring, instrumental and sensory analysis of algal and fish oils, as well as physiological significance of volatiles will be discussed.

LOQ 1b: Evaluation of Lipid Oxidation: Markers

Chairs: P. Smith, Cargill, Belgium; and H.-S. Hwang, USDA, ARS, NCAUR, USA

Development of a Rapid Screening Method for Determining the Impact of Ingredients on Pet Food Stability. E. Fuller, M. Smalley, and A. Chamberlin, Kemin Industries, USA.

The purpose of this study was to develop a rapid bench-top method for screening ingredients to determine their influence on pet food stability, without the need of producing the extruded kibble. This method will be helpful when developing antioxidants targeting specific diets.

Most pet food ingredients cannot be tested for the extent of oxidation using traditional methods due to their low fat content. In the developed method, 10 g of tested ingredients were mixed with 90 g of canola oil. Samples were stored at 37°C, with shaking, and tested for peroxide values using the FOX II method.

This screening method was used to compare the effects of animal meals, various protein, carbohydrate, and fiber sources on canola oil stability. It was found that most ingredients had a dramatic effect on oxidative stability of canola oil, either positive or negative. Interestingly, we learned that the combination of stable ingredients can cause an adverse effect on the oxidative stability of canola oil.

A rapid screening bench-top model was developed to test ingredients of pet food to determine their possible adverse effects in diets. Results suggest that the combinations of ingredients are more problematic than the individual ingredients.

NMR Spectroscopy for Assessment of Lipid Oxidation During Frying. H.S. Hwang, USDA, ARS, NCAUR, USA.

Except for total polar compounds (TPC), polymerized triacylglycerols (PTAG) and fatty acid composition, most other current standard methods for lipid oxidation detect very small amounts of oxidation products such as hydroperoxides, conjugated dienes, aldehydes, and epoxides. Therefore, amounts of these products could vary with a slight change in oxidation conditions and controversial results are frequently found due to different experimental conditions. In contrast, ^{1}H NMR spectroscopy method monitors changes in the starting oil molecules and several research groups have already reported that this method is very reliable. We have also conducted the research on ^{1}H NMR spectroscopy and further proved that this method is a very convenient and reliable method to determine the level of oil oxidation during frying. In our study, the triacylglycerol backbone peak was used as a standard peak and relative peak areas of protons located in reactive sites of oil molecules including olefinic, bisallylic and allylic protons were monitored. Strong correlations between the amount of PTAG and losses of olefinic, bisallylic and allylic proton peaks were observed indicating that this method offers highly reliable, non-destructive, fast analysis of lipid oxidation. Identification of oxidation products using ^{1}H NMR and ^{13}C NMR will also be discussed.

Interfacial Behavior and Rheology of Oxidized Proteins and Lipids. C.C. Berton-Carabin, A. Rovalino, A. Schröder, K. Schroën, and L. Sagis, Wageningen University, The Netherlands.

Food proteins (e.g., dairy proteins) are widely used in many food applications, for example, in emulsion-based products. Many processes involve thermal or mechanical stress, which can change the native structure of proteins and hence their functionality. In addition, in the presence of other reactive molecules (e.g., oxidizing unsaturated lipids), proteins can also be subjected to chemical modifications, such as oxidation. However, little is known on how such modifications of proteins affect their interfacial behavior and their emulsifying properties.

We investigated the effect of oxidation of dairy proteins on their adsorption kinetics and interfacial rheology at the oil-water interface using a drop tensiometer. The effect of lipid oxidation products on protein films was similarly studied. Interfacial films formed from oxidized whey proteins were found to be less elastic at small deformation values, compared to native whey proteins, and displayed strain hardening in compression and strain thinning in extension, upon increasing deformation. The presence of oxidized lipids also greatly decreased the elasticity of native protein-based interfaces. Protein and lipid oxidation can thus alter the formation and properties of oil-water interfaces, which may in turn affect the quality of food emulsions.

Oil Oxidation in Frying: A Refined Oxidation Model for Diverse Applications. P. Smith[1], A. Menzel[1], and S. Smith[2], [1]Cargill, Belgium, [2]Cargill, USA.

A model for the oxidation of oil under accelerated oxidation conditions has been presented earlier. Detailed understanding of the mechanisms of oil oxidation has been obtained. However real-life frying applications are somewhat more complex. Interactions with food, moisture, etc. occur. Also antioxidants or may be added to improve oil life. Active oil management techniques can also be used in order to prolong the oil life. Therefore the real process is more complex than described in the previous model. There should be a significant difference in behaviour between a restaurant fryer and an industrial-scale par-frying process.

We have refined the model to further understand such industrial systems. This allows application to specific conditions found in a particular process and so to predict degradation behaviour inparticular systems. The role of the different components in the fryer on oil oxidation must be measured and characterized. We have added foods, moisture, antioxidants and oil management to the model. As well as delivering a more effective model this process enables us to develop an improved understanding of the effect that these components have on oil oxidation. The effect of specific antioxidants is considered and analysed.

The application of oil oxidation to different systems will be presented and possibilities for further developments considered.

Do Free Fatty Acids Promote Lipid Oxidation? H.K. Abaidoo-Ayin, P. Jadhav, and S. Lumor, Delaware State University, USA.

A handful of publications have implicated free fatty acids (FFA) in the lipid oxidation process without outlining the mechanism by which this occurs. These conclusions were based on the Rancimat studies which showed increases in induction times of oils spiked with FFA. Although the Rancimat test is a good indicator of oxidative stability, it measures conductivity, a property that increases with increasing acidity. In order to establish the contribution of FFA to lipid oxidation, methods that do not measure conductivity should be more appropriate. In this study, olive oil samples spiked with oleic acid (0 – 5%) were subjected to a controlled accelerated oxidation in an oven at the same temperature (80^{o}C) for varying times (6, 12, 24, 36, 48, 60 and 72h). We monitored peroxide value (PV), and preliminary results show no significant differences in PV between the spiked oil samples and the controls. Methods for monitoring secondary products of lipid oxidation are currently underway to confirm our initial findings.

LOQ 2: Stabilization Strategies of Omega-3 Fortified Foods

Chairs: N. Yang, Kalsec Inc., USA; and F. Shahidi, Memorial University of Newfoundland, Canada

Stability and Stabilization of Omega-3 Oils and Foods. F. Shahidi, Memorial University of Newfoundland, Canada.

Omega-3 polyunsaturated oils and foods containing them are prone to oxidative changes due to the weak bis-allylic carbon-hydrogen bonds. The products of oxidation of omega-3 polyunsaturated fatty acids (PUFA) include propanal and acrolein, among others. Stabilization of omega-3 oils may be achieved by use of antioxidants, by microencapsulation or a combination thereof. Depending on the products' matrix or the type of antioxidant, stabilization of products is possible, albeit to different degrees. Examples will be provided to illustrate the parameters involved and compositions/unit operations that render the effects in selected products.

Formation and Stabilization of Nanoemulsion-based Delivery Systems for Omega-3 Fatty Acids. R. Walker[1], E.A. Decker[1,2], and D.J. McClements*[1,2], [1]University of Massachusetts Amherst, USA, [2]King Abdulaziz University, Saudi Arabia.

The incorporation of omega-3 fatty acids into foods and beverages is often challenging due to their low water-solubility, poor oxidative stability, and variable bioavailability. Nanoemulsions offer a promising way to incorporate omega-3 fatty acids into liquid food systems like beverages, dressing, sauces, and dips. Nanoemulsions are colloidal dispersions that contain small oil droplets (r < 100 nm) that may be able to overcome many of the challenges of fortifying foods and beverages with omega-3 fatty acids. The composition and fabrication of nanoemulsions can be optimized to increase the chemical and physical stability of oil droplets, as well as to increase the bioavailability of omega-3 fatty acids.

Improved Stabilization Using Natural Antioxidants in Omega-3 Oils and Omega-3 Enriched Foods. C. Tian, J. McKeague, A. Uhlir, and P. VanAlstyne, Kalsec Inc., USA.

The health benefits of omega-3 fatty acids are well known, as foods fortified with omega-3s continue to be introduced into the marketplace. As the popularity of these enriched foods increases, so does the challenge of their oxidative stability. The presence of multiple double bonds in oils and foods enriched with omega-3 fatty acids makes them vulnerable to oxidation.

One solution is to use natural antioxidants, such as rosemary extract, green tea extract, ascorbic acid, hydrolyzed pea protein and mixed tocopherols. The effectiveness of these natural antioxidants in oils and foods with high contents of omega-3 fatty acids was evaluated. Overall, rosemary and hydrolyzed pea protein showed the most effectiveness in various fish oils and fish oil emulsions, respectively. More efficient stabilizations were achieved using a combination of natural antioxidants in both oils and foods.

The studies used oxidative stability index (OSI) to evaluate oil stability, and peroxide value (PV) to measure the oxidation of emulsions. Headspace hexanal and formal sensory analysis were also conducted to monitor the quality of omega-3 enriched emulsions and foods.

Antioxidant Activity of Sesamol and Gamma-oryzanol Towards Fish Oil. M. Fhaner[2], H.S. Hwang*[1], J.K. Winkler-Moser[1], E.L Bakota[1], and S.X. Liu[1], [1]USDA, ARS, NCAUR, USA, [2]University of Michigan-Flint, USA.

Two natural antioxidants, sesamol and gamma-oryzanol, were examined for their antioxidant activity towards omega-3 oil. Sesamol and gamma-oryzanol have been known to provide antioxidant effects at high temperatures such as those used for frying. In this study, the effects of 0.84mM and 8.4 mM oryzanol and sesamol in stripped fish oil at 30° and 50°C were examined and compared with butylated hydroxytoluene (BHT) and a commercial rosemary extract. Overall, gamma-oryzanol did not show an impressive antioxidant effect while sesamol on the other hand produced strong antioxidant activity towards the stripped fish oil. At 0.84 mM, the order of antioxidant effectiveness in reducing the peroxide value was rosemary extract > sesamol > BHT > gamma-oryzanol. However, at the higher concentration, 8.4mM, the order of antioxidant effectiveness was sesamol > rosemary extract > BHT > gamma-oryzanol. Conjugated diene values, head space volatiles, and fatty acid profiles including EPA and DHA showed the similar trend. With all data considered, it was determined that sesamol was better than the commercial rosemary extract at the higher concentration (8.4mM). Considering some

shortcomings of rosemary extract such as low solubility in oil and unique flavor, sesamol provides an effective natural antioxidant alternative to rosemary extract.

Stabilization Strategies for Omega-3 PUFA Enriched Foods. C. Jacobsen, Technical University of Denmark, Denmark.

The number of new food products enriched with omega-3 polyunsaturated fatty acids (PUFA) has increased dramatically during the last decade due to increasing consumer awareness about the health benefits these fatty acids offer. Due to their polyunsaturated nature, omega-3 PUFA are highly susceptible to lipid oxidation, which will result in undesirable fishy and rancid off-flavours. This presentation will discuss different strategies to reduce or inhibit lipid oxidation by 1) optimising the processing conditions, 2) utilising an omega-3 PUFA delivery system, and 3) addition of antioxidants. The presentation will demonstrate that emulsification conditions (type of equipment and processing temperature) significantly affect lipid oxidation in omega-3 PUFA enriched foods and that it is necessary to optimize the composition and structure of omega-3 PUFA delivery systems for the specific food product in order to minimize oxidation. Examples on the antioxidant efficacy of different phenolipids in omega-3 PUFA enriched foods will also be given.

Seaweed Extracts to Inhibit Lipid Oxidation in Fish-oil-enriched Mayonnaise. P.J. Honold[1], D.B. Larsen[1], H.G. Kristinsson[2], R. Jonsdottir[2], and C. Jacobsen[1], [1]Technical University of Denmark, Denmark, [2]Matís ohf, Iceland.

Natural antioxidants derived from marine algae have a high content of bioactive components with potential for improving oxidative stability of food systems. In this presentation results from our ongoing work on the brown algae *Fucus vesiculosus* will be presented. This seaweed contains a wide range of bioactive compounds with potential antioxidant activity. *In vitro* antioxidant properties of *F. vesiculosus* extracts have been found to be related to a high content of phlorotannins.

A storage experiment was performed in which four different extracts from *F. vesiculosus* were added to fish oil enriched mayonnaise in different concentrations (1.5 and 2g/kg mayonnaise). Lipid oxidation during storage was followed by determination of peroxide value, tocopherol content, fatty acid composition and development of secondary oxidation products. Characterization of the extracts was done regarding protein content, amino acid profile, pigments, tocopherols and trace metals content. Also the octanol/water partitioning coefficient of the phenolic compound was determined. Results showed that acetone was the best extraction solvent to extract phenolic compounds. The good antioxidant properties of this extract are linked to a high phenolic content and good radical scavenging and iron chelating abilities.

Phenolic Antioxidants for the Stabilization of PUFA Oils. W. Indrasena, Z. Tan, and J. Kralovec, DSM Nutritional Products, USA.

Fish and algal oils containing poly unsaturated fatty acids (PUFA) such as eicosapentaenoic acid and docosahexenoic acid are vulnerable for rapid oxidation and the oxidized oils contribute unpleasant flavour profiles to such oils and food products containing them. Phenolic compounds containing tocopherols are widely used to retard oxidation.

Effect of various phenolic antioxidants including tocopherols, catechins and rosemary extract with some of their synergistic antioxidants on the oxidative and sensory stability of fish and algal oils have been studied. Oxidative stability index, PV, *p*-AV and CD were monitored during ambient temperature storage. Sensory of some selected samples were also monitored as required. Oxidative stability of the oil varied depending upon the type of antioxidant and synergistic compounds increased the oxidative stability although the sensory stability of oils with certain antioxidant combinations was not clear whereas certain antioxidant combinations improved both sensory and stability. This presentation contribute some information not only on the use of antioxidants to improve the sensory and stability of oils containing highly unsaturated fatty acids but also on some facts pertaining to the analysis and availability of phenolic antioxidants and limitations of their application in food grade fish and algal oils.

LOQ 3a: Challenges in the Commercialization of New Antioxidants

Chairs: S. Bis, Kemin Industries Inc., USA; J.K. Winkler-Moser, USDA, ARS, NCAUR, USA; and R. Nahas, Kalsec Inc., USA

***"Removing the Weeds"*—The Challenges in Commercializing Natural Plant Extracts.** R. Nahas, Kalsec, Inc., USA.

Market trends are showing a heavy preference towards natural ingredients in a global effort to replace artificial ingredients, simplify labels, and satisfy emerging consumer preferences. This effort has industry-wide implications on price, market positioning, shelf-life quality and sensory attributes. There are currently several available natural solutions using spice and herb extracts to color, improve the taste and protect the freshness of many foods and beverages. However, not all of these extracts are capable of meeting the economic and shelf-life requirements of their artificial counterparts. As a result, the development of new naturally-sourced ingredients, such as antioxidants, colors and flavors, is highly active. While introducing new artificial ingredients is very time and resource consuming, introducing natural ingredients can provide a completely different set of challenges. This paper identifies some of the main hurdles that are encountered while developing new ingredients. Specific examples of challenges in the development of new natural food ingredients with an emphasis on the labeling, marketing, safety, economics, technical and sensory aspects will be provided.

Plants: 'Factories' for Renewable Ingredients. S. Wei and S. Nayak, Kemin Personal Care, USA.

To reduce reliance on synthetic ingredients and reduce the carbon footprint, consumers are moving towards natural and sustainable ingredients in the cosmetic industry. Studies have discovered that the unique molecules found in plants can serve as both functional ingredients and skin actives. In order for a natural product to become a commercial reality, the production process must be optimized to make low color, low odor, stable and efficacious ingredients that can compete with synthetic ingredients.

For example, the use of rosemary in cosmetic is limited due to its strong characteristic color and odor. Other challenges include inconsistent quality and relatively high inclusion rates. Plant breeding for rosemary allows ascensions that have higher yield of target molecules and consistent biomass, which subsequently allows for a consistent product. Lecithin is another well-known cosmetic ingredient. The intense color, odor, and low stability and dispersibility restrict its uses in personal care formulations. An enzymatic modification and selective extraction process not only overcomes those obstacles but also provides better functionalities.

The ability to harness renewable sources of bioactive molecules in combination with the right processing technology can provide natural and sustainable cosmetic ingredients.

Challenges and Opportunities: Commercialization Potential of Newer Antioxidants. U. Thiyam-Hollander*[1], M. Eskin[1], and C. Rempel[2], [1]University of Manitoba, Canada, [2]Canola Council of Canada, Canada.

In the search for new antioxidants, Canolol extracted from canola seed, crude oil, distillates and the by-product press cake represents a newer natural antioxidant. While it has been shown to have potent antioxidant properties, it is limited for commercial use unless it can be produced in adequate amounts. This can only be met by a scale-up production which will be addressed in this paper. An improved method for the production of canolol will be presented as well as examples of its antioxidant and anticancer properties. It is evident that canolol has considerable potential as an antioxidant in edible oils.

GRAS: The FEMA Flavor Perspective. S. Taylor[1,2], [1]Verto Solutions, USA, [2]FEMA Expert Panel, USA.

For more than 50 years the Flavor and Extract Manufacturers Association of the United States (FEMA) has had a program in place to assess the safety and "GRAS" (generally recognized as safe) status of flavor ingredients, using an independent Expert Panel. Sean Taylor, the Scientific Secretary to the FEMA Expert Panel, will describe the process and the FEMA GRAS program's approach to achieve a robust GRAS evaluation for new flavor ingredients, as well as the challenges for the GRAS concept.

LOQ 3b: Novel Antioxidative Strategies

Chairs: W. Indrasena, DSM Nutritional Products, Canada; and K. Miyashita, Hokkaido University, Japan

Preventive Effect of Sphingoid Base on Volatile Compound Formation in Fish Oil Oxidation. M. Uemura[1], A. Suzuki-Iwashima[2], M. Shiota[2], M. Hosokawa[1], and K. Miyashita*[1], [1]Hokkaido University, Japan, [2]Megmilk Snow Brand Co., Ltd., Japan.

Amine containing glycerophospholipids (PLs) such as phosphatidylcholine (PC) and phosphatidylethanolamine (PE) have been well known as synergists in combination with tocopherols. On the other hand, little has been known on the effect of sphingolipids (SLs), although they contain amines in their sphingosyl backbone. In the present study, we reported the strong antioxidant activity of sphingoid bases, a basic structural element of SL, on the oxidative stability of fish oil triacylglycerol (TAG). Fish oil TAG oxidation has been effectively inhibited in the presence of sphingoid bases such as sphingosine and sphinganine with a-tocopherol. This effect of sphingoid bases was much higher than those of PLs and SLs. The present study also showed that antioxidant compounds would be formed by the reaction between the amine group of sphingoid bases and the carbonyl groups of aldehydes formed in the very first stage of fish oil TAG oxidation; and then, the antioxidants from sphigoid bases could effectively prevent the formation of volatile compounds after that.

A Novel Technology to Increase Antioxidant Activity of an Antioxidant by Reducing Volatility. H.S. Hwang, J.K. Winkler-Moser, K. Vermillion, and S.X. Liu, USDA, ARS, NCAUR, USA.

During frying, an antioxidant is lost by reaction with radicals for its antioxidant activity, but it is also lost by decomposition and evaporation before it is able to exert antioxidant activity. Some low molecular weight antioxidants are often so volatile that they show much reduced antioxidant activity at high temperatures such as frying temperatures. In this study, it was hypothesized that an additive that can bind to an antioxidant could reduce volatility of the antioxidant. Twenty one food additives containing functional groups such as such as an amino, hydroxyl, ether, ammonium, phosphate, carboxylate, or sulfate group were tested and found to reduce volatility of antioxidants including sesamol, *tert*-butylhydroquinone (TBHQ), butylated hydroxyanisole (BHA), and butylated hydroxytoluene (BHT) in soybean oil. An NMR study indicated strong hydrogen-bonding between the phenolic OH group of the antioxidant and the functional group of the additive. A heating study with soybean oil at 180°C showed that the antioxidant showed significantly improved activity when the same molar amount of the additive was added. Correlation analyses showed that the antioxidant activity was well correlated with the antioxidant concentration retained. This new technology may be used for many other antioxidants for which volatility is a problem.

Preparation of Powdered Fish Oil for Nutraceutical Purposes. K. Nakagawa and T. Miyazawa, Tohoku University, Japan.

[Objective] Powdered oil has extensive application, which applicable to food processing, food additives, pharmaceutical intermediates, and health care products. Fish oil contains docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), and has received attention as a therapeutic agent. Taken together, we tried to develop a preparation method of powdered fish oil.

[Method & Results] The powdered fish oil could be produced by mixing fish oil with emulsifiers, gelatin and transglutaminase, then subjecting the mixture to freeze-drying and pulverizing. The presently developed powder contained high amounts of lipids (74% of dry weight; 152mg DHA/g, 41mg EPA/g). Nevertheless, the powdered oil had a good oxidation stability as compared to bulk liquid fish oil. Besides the oxidation stability, as we expected, the powdered fish oil showed sustained-release properties in our in vitro experiments.

[Discussion] In this study, we prepared powdered fish oil as a sustained-release formulation. Therefore, the fish oil contained in the powder is expected to be sustainably released in the gastrointestinal tract upon consumption. DHA and EPA are then gradually absorbed into the body, which may contribute to good health. To evaluate the possibility, we are performing human studies for future utilization of the powdered fish oil for nutraceutical purposes.

Impact of Phosphatidylethanolamine on the Antioxidant Activity of α-tocopherol and Trolox in Bulk Oil. L. Cui, D.J. McClements, and E.A. Decker, University of Massachusetts Amherst, USA.

Lipid oxidation in bulk oils is strongly influenced by oil-water interfaces. Amphiphilic phospholipids such as dioleoyl phosphocholine (DOPC) and dioleoyl phosphoethanolamine (DOPE) in bulk oils can form association colloids such as reverse micelles. These physical structures create interfaces that impact lipid oxidation chemistry. In this study, we examined how these reverse micelles influence primary antioxidants such as the nonpolar α-tocopherol and the polar trolox in stripped soybean oil. The results showed that DOPC reverse micelles decreased of the activity of 100μM α-tocopherol or trolox, compared to oil containing only α-tocopherol or trolox. On the other hand, high concentration DOPE increased the antioxidant activity of both α-tocopherol and trolox. The polar trolox exhibited better antioxidant activity than nonpolar α-tocopherol in the presence of both DOPC and DOPE reverse micelles because trolox partitioned more at the interfaces, which was confirmed by a fluorescence steady state study. Different ratios of DOPE to DOPC was added to oil containing 100μM α-tocopherol and antioxidant activity increased as the DOPE/DOPC ratio increased. HPLC showed that DOPE decreased the oxidation of α-tocopherol.

Antioxidant Activity and Sensory Assessment of a Rosmarinic Acid-enriched Extract of *Salvia Officinalis*. E.J. Bakota, J.K. Winkler-Moser, M. Berhow, F.J. Eller, and S. Vaughn, USDA, ARS, NCAUR, USA.

An extract of *S. officinalis* (garden sage) was prepared using supercritical carbon dioxide (SC-CO_2) extraction, followed by a Soxhlet hot water extraction. The resulting extract was enriched in polyphenols, including rosmarinic acid (RA), which has shown promising health benefits in animals. The extract contained RA at a concentration of 28.4mg/g, representing a nearly three-fold enrichment from the RA content in sage leaves. This extract was evaluated for phenolic content and antioxidant activity. It was then incorporated into soybean oil-in-water emulsions as a source of lipid antioxidants and compared to emulsions containing pure rosmarinic acid. Both treatments were effective in suppressing lipid oxidation. The extract was evaluated by a trained sensory panel in a tea formulation. While the panel could discriminate among extract-treated and control samples, panelists demonstrated high acceptability of the sage extract in a tea. This opens the door for additional food formulations incorporating the extract and the investigation of antioxidant activity in these formulations.

LOQ 4a: Effects of Functional Ingredients on Shelf Life

Chairs: M. Hu, DuPont Nutrition & Health, USA; and C. Jacobsen, Technical University of Denmark, Denmark

Functional Properties of Esterified Phenolic Compounds. C. Grajeda-Iglesias[1], E. Salas[2], M.L. Suárez-Quiroz[3], L. Muñoz Castellanos[2], O. González-Ríos[3], P. Villeneuve[4], and M.C. Figueroa-Espinoza[1], [1]Montpellier SupAgro, France, [2]Universidad Autónoma de Chihuahua, Mexico, [3]UNIDA, Mexico, [4]CIRAD, France.

The bioactivity of some phenolic compounds was evaluated by measuring antiradical (DPPH), antioxidant (ORAC, CAT), and antifungal activity, before and after chemical or enzymatic lipophilization (esterification with different alkyl chains (C_1-C_{18})). Phenolic compounds are excellent antioxidants but they are not fully soluble on lipid-rich matrices, like some food, pharmaceutical or cosmetic products. To counteract this behavior, lipophilization was applied to increase their solubility in lipidic media.

Phenolic compounds were extracted from coffee (*Coffea arabica*), roselle (*Hibiscus sadariffa*) and pomegranate (*Punica granatum*), *i.e*. chlorogenic acid, protocatechuic acid, and extracts rich in hydrolysable tannins, respectively. The alkyl esters presented antiradical, antioxidant, and antifungal properties. Depending on the chain length, lipophilization improved the functional properties of the original phenolics, *i.e.*, the CAT value was higher for C12 chlorogenates and for C2 and C4 protocatechuates, and the anti-*Aspergillus* activity was higher for C8 chlorogenates and C12 protocatechuates.

In conclusion, antioxidant and antifungal activities of phenolic compounds can be improved by esterification with an alkyl chain. This could be an innovative way to synthesize molecules with a good therapeutic value or a potential use as preservative in food or cosmetics.

Strategies to Improve the Oxidative Stability of Bakery Products Fortified with Heme Iron. M. Alemán, R. Bou, A. Tres, R. Codony, and F. Guardiola*, University of Barcelona, Spain.

Iron deficiency is the most common and widespread nutritional disorder in the world, being more prevalent in women at childbearing age and children. The fortification of food products with non-heme or heme iron is a common strategy employed to prevent and/or overcome this disorder. Heme iron bioavailability is higher, but, as non-heme iron forms, it promotes oxidation.

Our aim is to improve the oxidative stability of bakery products fortified with heme iron. Since palm oil is widely used in the formulation of bakery products and chocolate fillings, a model consisting in palm oil fortified with heme iron was used to assess the efficacy of the following strategies: the addition of antioxidants; the encapsulation of heme iron by co-spray-drying; and the combination of both. The strategies that were shown to be efficient in this model were further assessed in sandwich-type cookies filled with a heme iron-fortified chocolate cream. In these cookies, the oxidative stability and consumers' overall acceptability was studied during storage in the dark at room temperature. After storage for one year, those cookies that combined the addition of ascorbyl palmitate and the co-spray-drying of heme iron with calcium caseinate were accepted by consumers and showed lower oxidation values than other fortified cookies.

Functional Frying Oils Prepared by Using Olive Leaves from Sari Ulak and Gemlik Olives. T.M. Keceli, M. Degirmen, M. Akmanlar, S. Güler, B.N. Mercankaya, and O. Ozdemir, University of Cukurova, Turkey.

Recently, a number of studies have proposed that some by products could be a source of natural antioxidants. The aim of this research was to evaluate the efficacy of extracts olive leaf extracts prepared from Sari Ulak and Gemlik in frying conditions. The extracts were added into oils at 100 and 200 ppm level. Frying oils were prepared by using sunflower oil, refined and extra virgin olive oil and commercial frying oil or their model blends and examined during repeated deep fat frying processes. It was found that Sari Ulak olive leaf extract were more effective than Gemlik olive leaf extract for pure and model blend frying oils enrichment. Sunflower oil did not show good thermal stability during the repeated deep fat frying cycles however; extra virgin olive oil and commercial frying oil were the best oils. Enrichment of frying oils with olive leaf extracts developed the thermal oxidative stability of extra virgin olive and commercial frying oil during repeated frying cycles. The results indicated that olive leaf extracts can be safely used as substitutes for synthetic antioxidants, extend the usage life of

frying oils in food industry as functional food ingredient.

Oxidative Status and Effect of Raw Materials on Lipid Oxidation in Skin Care Products. B.R. Thomsen[1], G. Hyldig[1], R. Taylor[2], J. Gregory[2], P. Blenkiron[2], and C. Jacobsen[1], [1]Technical University of Denmark, Denmark, [2]Glaxo Smith Kline, UK.

Odour of skin care products is highly important for quality. During consumer-storage, they may be exposed to relatively high temperatures and light, therefore lipid oxidation may occur.

In an earlier study, we assessed lipid oxidation in skin care products. We identified a number of markers for lipid oxidation including volatile compounds such as pentanal and heptanal. We also detected a volatile compound, butane nitrile, which we have not detected before. The origin of this compound is at present unknown. To our knowledge, it is not present from the beginning. To understand the route of reactions leading to volatile compounds, two experiments were carried out. The aim of the first experiment was to identify raw materials responsible for the development of these volatiles. Nitrogen-containing raw materials and antioxidants were tested.

The aim of the second experiment was to investigate the route of reactions by model studies designed to explore the chemical reactions: A model study was conducted with and without selected ingredients which were possible to remove and maintain stability. These samples were stored for two months at 40°C. The content of volatile compounds was measured and compared to the markers found for lipid oxidation.

Fate of Annatto Tocotrienols During Frying and Effect on Quality and Stability of Tortilla Chips. J.K. Winkler-Moser and E.L. Bakota, USDA, ARS, NCAUR, USA.

Tocotrienols are antioxidant compounds that are increasingly valued for their health benefits. Annatto is a rich source of delta tocotrienol. Annatto extract containing tocotrienols was added to mid-oleic sunflower oil, and tortilla chips were fried in the oil over three-day frying experiments. The oil quality, including triacylglycerol polymerization, total polar compounds, and tocopherol and tocotrienol degradation, was monitored. Tocotrienol incorporation into tortilla chips was measured. In addition, the quality of fresh tortilla chips, as well as tortilla chips stored under accelerated oxidation conditions was determined using a trained sensory panel. Tocotrienols had little effect on the oil degradation during frying and no significant impact on the sensory quality of tortilla chips. Tortilla chips fried in oil with annnatto extract had moderately better shelf stability compared to the control, based on sensory evaluation and headspace analysis.

LOQ 4b: Lipid Oxidation in Low-moisture Foods and Emulsions

Chairs: S. Zhou, Mallett and Company, Inc., USA; and R. Zahr, Caldic Canada Inc., Canada

Oxidative Stability and Shelf Life of Oils/Fats-containing Dry Foods. M. Hu and J. Erdmann, DuPont Nutrition & Health, USA.

Oxidative stability and shelf life study of oils/fats-containing dry foods is critical for a food company to develop new products. However, oxidative stability and shelf life study of the dry foods have not been thoroughly studied. The objective of the presentation is to evaluate oxidative stability and shelf life of various dry foods. Oxipres, checkmate, PV, hexanal, propanal and sensory data are used to access the oxidative stability of extruded corn chip, milk and egg powders, encapsulated fish oil and cauliflower soup powders, chicken meal and extruded dry pet food over ambient / accelerated storage period. The results suggested that Oxipres data at 100°C might not be used to accurately evaluate oxidative stability and shelf life of dry foods. PV data may not be in agreement with hexanal and sensory data over storage and therefore may not be a good marker for the dry foods. Lipid co-oxidation with protein needs to be considered when evaluating oxidative stability of lipid/protein-containing dry foods, since the dry foods were getting rancid over storage but PV and hexanal did not increase. Lipid oxidation in solid phase could be different from that in liquid phase, such as bulk oil and o/w emulsions. Thus lipid oxidation in the solid and liquid phases may follow different oxidation mechanisms.

Ascorbic Acid: Oxygen Scavenging Properties and Its Effect on Lipid Oxidation in Oil-in-Water Emulsion System. S. Uluata[1,2], D.J. McClements[2], and E.A. Decker[2], [1]Inonu University, Turkey, [2]University of Massachusetts Amherst, USA.

Lipid oxidation is a serious problem for oil containing-food products. Oxygen is a critical factor that can influence the susceptibility of lipid-containing foods to oxidation. Common techniques to remove oxygen include vacuum packaging, flushing nitrogen, using modified oxygen absorbing packaging. However, these techniques are not suitable for all products. An alternative technique is use of an edible oxygen scavenger to remove oxygen within the food. Ascorbic acid (AA) is a particularly promising antioxidant because of its natural label and multiple antioxidative functions. In this study, AA was tested as oxygen scavenger in buffer and an oil-in-water (O/W) emulsions. The effects of transition metals on AA's ability to scavenge oxygen were determined. AA was able to almost completely remove dissolved oxygen rate in a buffered solution.Transition metals (Cu^{+} > Fe^{2+}) significantly accelerated the degradation of AA but had little impact on increasing the rate of dissolved oxygen removal. AA decreased dissolved oxygen in a 1% O/W emulsion system 31.9-61.3% and delayed the formation of the headspace hexanal in the emulsion from 7 to over 20 days. This research shows that when AA is used in O/W emulsion system oxidation of the emulsion system can be delay.

Antioxidant Activity of Corn and Dry Distiller's Grain Extracts in Chips. J. Kallenbach, B. Cobb, S. Pryor, and C. Hall, North Dakota State University, USA.

The trend by the food industry to use natural food additives has regenerated the interest in natural antioxidants. Dried distillers' grain (DDGs) could be used as a source of antioxidants. Published literature supports that carotenoids, phytosterols and tocopherols make up some of the important antioxidants in DDGs. Although DDGs are an abundant source of many functional ingredients, the evaluation of these as antioxidant has not been investigated extensively. The objective of this study was to assess the antioxidant activity of DDG extracts in crackers. Crackers were formulated with 500ppm of a DDGs extract obtained through saponification. The crackers were baked at 400°C and stored at 38°C over the course of four weeks. Sensory evaluation was completed by a trained panel to evaluate the change in rancidity every 15 days while peroxide values and hexanal content were measured weekly. The sensory evaluation of rancidity indicated changes over the course of the study and that a grassy flavor developed with storage. Peroxide values and hexanal contents increased over time. This study showed that DDG extracts had good antioxidant activity, which might be related to the carotenoids, phytosterols and tocopherols present in the extracts.

Localization and Efficacy of Antioxidants in Emulsion-based Delivery Systems. L. Cheong[1], Y. Wang[1,2], X. Wang[2], and T. Yang[1], [1]Wilmar (Shanghai) Biotechnology R&D Center, China, [2]Jiangnan University, China.

Oxidation of lipophilic ingredients is a major cause of degradation in sensory and nutritional quality of food products. It leads to loss of macro- and micronutrients, formation of potentially toxic compounds and volatile compounds which is generally associated with unpleasant flavors. Oxidation in emulsified system is often due to interaction between aqueous transition metals ions and peroxides located at or close to the interface which resulting in the formation of reactive radicals. Thus, the interface is widely regarded as critical to the oxidative stability of the lipophilic ingredients. Antioxidants located at the interface have been hypothesized to have higher efficacy in countering oxidation. Present study looks at the efficacy of the different antioxidants in palm- and soy-based bulk and emulsified systems.

Applications of Lipid Soluble Catechins in Food Emulsions and Frying Oil. L. Ban, J. Randall, and W.D. Schroeder, Kemin Food Technologies, USA.

Food emulsions and frying oil are both prone to oxidation for the high surface area that the lipid molecules interact with air, moisture and reagents that promote oxidation. Controlling interfacial oxidation is crucial for the stability of food emulsions. In addition, during deep frying, multiple phases co-exist in the system making chemical and physical reactions accelerate at the interface of different phases. Currently, synthetic ingredients dominate the market to stabilize food emulsions and frying oil. However, the trend to move away from them calls for alternative solutions for slowing down lipid oxidation. In this study, a few plant derived ingredients were evaluated for their effectiveness in delaying lipid oxidation. Among them, lipid soluble catechins are new plant derived ingredients originating from green tea. A few screening methodologies, including one with high throughput capabilities, were applied for identifying the best combinations. The results showed that lipid soluble catechins, either alone or in combination with other components, had great promise in the stabilization of mayonnaise, salad dressing and frying oils. In some cases, it has shown to be able to compete with synthetic antioxidant in the stabilization of food stuff. The mechanism of its good efficacy was proposed based on its unique chemical structure.

LOQ 5a: General Lipid Oxidation and Quality

Chairs: C. Hall, North Dakota State University, USA; and U. Nienaber, Kraft Foods, USA

Novel Phosphated Mono- and Di-glycerides that Promote Enhanced Oxidative Stability in Edible Oils. S. Kelkar, J. Wang, and C. Fouts, Vantage Specialty Chemicals, USA.

Novel phosphated mono- and di-glycerides (PMDGs) derived from edible oils were prepared and studied for antioxidant properties. Although PMDGs are widely used as emulsifiers, exceptional antioxidant effects were recently observed on one PMDG variant. Varying concentrations of this PMDG ranging from 0.02% to 0.5% were added to different lipid systems based on high mono-unsaturation (canola oil), di-unsaturation (soybean oil), and poly-unsaturation (fish oil) for evaluation of antioxidant activity. For comparison, leading antioxidants (TBHQ and rosemary oil) were added to the lipid systems at similar dosage levels. Oil samples were heated to 204°C to simulate frying conditions and held for 12 hours. Color, free fatty acid content, and fatty acid composition were monitored for the duration of the study. Remarkable color integrity was observed for the PMDG treated samples in comparison to TBHQ and rosemary oil. Low free fatty acid content and reduced percent change in unsaturation was also observed for PMDG samples in comparison to other antioxidant samples. Based on this data, it was evident that PMDG is a superior antioxidant compared to TBHQ and rosemary oil for enhanced oxidative stability of edible oils at frying oil conditions.

Impact of Association Colloids on Lipid Oxidation in TAG and Fatty Acid Ethyl Ester. R. Homma[1,2], D.J. McClements[2], and E.A. Decker[2], [1]Kao Corp., Japan, [2]University of Massachusetts Amherst, USA.

Association colloids formed by surface active minor components play important role on oxidative stability of oils. In this study, multiple surface active minor components including phospholipids, mono and diacylglycerols, fatty acids and sterols were used to form nanostructures in stripped fatty acid ethyl esters. The critical micelle concentration (CMC) of the multiple components in fatty acid ethyl esters (FAEE) such as ethyl oleate, ethyl linoleate and ethyl esters made of fish oil were determined. Moreover, the impact of the association colloids formed by these components on oxidative stability of FAEE were studied. The CMC of the multiple surface active components increased with increasing degree of unsaturation of the FAEE. The association colloids didn't show prooxidative activity in FAEE as they do in triacylglycerols. The impact of the association colloids on oxidation stability of vegetable oils and fish oil were also studied. Understanding how association colloids impact on lipid oxidation in different oils could provide a new perspective to improve oxidative stability in oils.

Effect of Triglyceride Fatty Acid Composition on Conjugated Linoleic Acid Rich Soy Oil Oxidation. S. Lele and A. Proctor, University of Arkansas, USA.

A CLA rich-soy oil (CLARSO) has been obtained by heterogeneous catalysis of soy oil linoleic acid. Conventional soy oil linoleic acid, and other fatty acid species, are distributed among a variety of triacylglycerols (TAG). Therefore, the objectives of this study were to: (1) identify the major TAG species in CLARSO and fatty acid composition of each fraction relative to that of soy oil and (2) determine the change in CLARSO TAG fraction fatty acid composition during CLARSO oxidation. Control soy oil and CLARSO TAG fractions were identified by analytical HPLC with ELSD and UV detection. Semi-prep HPLC was then used to obtain CLARSO TAG fractions for fatty acid analysis by GC-FID as FAME. CLARSO oxidation was evaluated by incubating six 2 g samples at 50°C. Daily duplicate samples were taken for TAG fraction separation by HPLC prior to GC-FID FAME fatty acid determination. The stability of linoleic acid and linolenic acid varied among TAG fractions. The main factor affecting linoleic acid loss was the amount initial of linolenic acid in the fraction and was independent of CLA decline. Loss of CLA did not promote linoleic or linolenic acid loss, which suggests CLA as a possible antioxidant.

Effect of Deep-fat Frying on the Properties of Virgin Olive Oils Produced at Different Harvest Times. T.M. Keceli, M. Degirmen, M. Akmanlar, B.N. Mercankaya, F. Ozturk, A. Dishan, M.G. Kartal, O. Ozdemir, S. Guler, and G. Alis, University of Cukurova, Turkey.

Virgin olive oil is the most commonly used cooking oil in Mediterranean countries and frying is an important technique employed in domestic and industrial food preparation. Olive oil harvested from the olives at October, November and December By olive oil plant coded as Al, Ak, K and Y (Oct, Nov,

Dec) were assessed during repeated deep-fat frying of French fries. Polar compounds content of oils were also recorded and frying was ended when the oil polar content value reached to 25. The results showed that peroxide value were increased, however significant increases were found on 232 and 270nm, TBA and decreases on FFA, chlorophyll, carotenoid, tocopherol, phenolic content and antioxidant activity were found. Harvest time and olive oil plant had a significant effect during deep-frying of potato chips. Polar compounds content were similarly increased for K and Al and Y and Ak olive oil plant. Chlorophyll and phenolic contents were reduced at 66 and 84%, respectively at K-Nov olive oil plant. Carotenoids, tocopherol and antioxidant activity were reduced 76, 86 and 55% at Al-Oct, K-Dec and Y-October, respectively. Virgin olive oil shows good behaviour during frying in resistance to formation of polar compounds and thermal stability.

LOQ 5b: *trans* Fat Alternatives: Sources, Chemistry, and Oxidative Stability

Chairs: S.P.J.N. Senanayake, DuPont Nutrition & Health, USA; and S. Knowlton, DuPont Co., USA

Functionality Studies on High-oleic Soybean Oil. J.J. Tuinstra[1] and F.J. Flider[2], [1]Stratas Foods, LLC, USA, [2]Qualisoy, USA.

High oleic soybean oil, a high-stability, trans-fat-free oil, represents a tremendous opportunity for the food and food service industries. *trans*-fatty acid containing partially hydrogenated oils are being removed from our food supply, and replaced by a new generation of high performance oils, including high oleic soybean oil. In deep frying and spray oil application testing, the high performing, high oleic soybean oil delivers comparable and often superior performance relative to conventional partial hydrogenated soybean oil, commodity oils, and other high oleic oil options.

Impact of Oil Type on Oxidative Shelf Stability of Food Products. A. Syed, Dow AgroSciences, USA.

Background: Food applications research was conducted to understand the stability of high oleic oils in foods. Several food products, made with different high stability oils, were stored at elevated storage temperatures and the relative oxidative stability was studied using electronic nose (E-nose), OxiTester, as well as other conventional analytical methods.

Method: Food products made with oils high in oleic acid and low in linlenic acid showed significant resistant to oxidation, as compared to conventional oils. High oleic oils performed as well or better than conventional oils enhanced with chemical antioxidants.

Conclusion: High oleic oils are suitable for formulating foods without antioxidants, allowing food manufacturers to have a cleaner ingredient label.

Maximize Shelf Life of Your Fried and Baked Products. M.K. Gupta, MG Edible Oil Consulting, USA.

Processed food products are packaged for distribution through the normal distribution channel. This is done through various methods, such as: Store-door Delivery, Central Warehousing and Distribution, Regional warehousing and Distribution, Sales and Distribution through Brokers, Overseas sales typically shipped by boat. The product can be shipped under Ambient condition, Refrigerated condition or in Frozen Containers. In all cases, the object is to be able to deliver the product in good condition to the retail or to the point of distribution. The product is expected to have acceptable taste and texture as the consumer uses it before the date of expiration, stamped on the package.

This presentation discusses the various factors that affect the product shelf life from the very moment it is made and the practical methods to retard the product degradation process.

The Development and Current State of High Oleic Soybean Oil. S. Knowlton, DuPont Co., USA.

This past decade has seen major changes in the oil used for domestic consumption in the US driven largely by consumer demand to avoid trans-fat. Food service and food manufacturers continue to choose oils based on a multitude of factors including price, performance, taste, availability, and health perceptions. For both liquid and solid fat applications, oils which are stable for extended periods and can be obtained at a reasonable cost, are preferred over niche, high cost selections. Special processing technologies and natural additives expand the options available for product formulation. In many cases, high oleic oils are the best choice from a performance perspective but may be hindered from wide spread use for other reasons. This talk will focus on high oleic soybean oil, it's development and recent entry into the market, performance characteristics and the projected expansion of this oil in the coming years.

LOQ-P: Lipid Oxidation and Quality Poster Session

Chair: X. Pan, DuPont Health & Nutrition, USA

1. **Production of Omega-3 Rich Fish Oil from By-products of Danish Trout.** P.J. Honold, M.L. Nouard, and C. Jacobsen, Technical University of Denmark, Denmark.

Rainbow trout is the main species produced in Danish fresh water farming. Filleting by-products as head, bones, tail and intestine is at present turned into ensilage and sold to the mink industry with low revenue. To create more value from the trout filleting by-products could be used for the production of fish oil suitable for human consumption.

Production of fish oil from by-products involves: mincing of the raw material, heating, separation in a three phased decanter centrifuge, reheating of the oil fraction before a final separation of oil and residual water.

The aim of this study is to investigate the effect of the processing temperature during extraction on the oxidative stability of fish oil produced from fish by-products. We investigated the effect of varying processing temperatures (70/90°C) in different steps during extraction. The raw material and crude oil were characterized by lipid content, fatty acid profile, free fatty acids and tocopherol. The oxidative status was measured by PV, AV, volatile secondary oxidation products and an accelerated oxidation test. Secondly, we investigated the effect of temperature on the two fractions processed together. The effect of high and low omega-3 content in the raw material on the oxidative stability was also evaluated.

2. **Effect of Different Wall Materials on the Physicochemical Properties of Spray-dried Microencapsulated Chia Oil.** U. Us Medina[4], V.Y. Ixtaina[1], L.M. Julio[1], J.R. Wagner[2], S.M. Nolasco[3], and M.C. Tomás*[1], [1]Centro de Investigación y Desarrollo en Criotecnología de Alimentos (CIDCA) (CONICET La Plata-UNLP), Argentina, [2]Universidad Nacional de Quilmes (UNQ), Argentina, [3]Universidad Nacional del Centro de la Provincia de Buenos Aires (UNCPBA), Argentina, [4]Universidad Autonoma de Yucatán (UADY), Mexico.

The objective was to study the influence of wall material composition on the physicochemical and oxidative stability of spray-dried microencapsulated chia oil. Chia seed oil (10% wt/wt) was homogenized using a high pressure homogenizer (600 bar) with different wall material solutions (core/wall material ratio=0.33): sodium caseinate+lactose (NaCas+Lac), NaCas+maltodextrin (NaCas+Mx), Mx+chia proteins (Mx+Prot), with and without chia mucilage (Muc). These emulsions (E) were microencapsulated by spray-drying at inlet/outlet temperatures of 170/90ºC. The encapsulation efficiency was: NaCas+Lac+Muc(96.2±0.4%)~NaCasLac(95.2±0.4%) >NaCas+Mx+Muc(86.6±0.2%)>NaCas+Mx(71.3±0.1%)>Mx+Prot(57.7±3.0%)~ Mx+Prot+Muc (53.4±1.0%). The moisture content of microcapsules was 2.7-4.5% d.b., while water activity ($a_{w\ 25ºC}$) was 0.31-0.43. The particle size distributions of E and reconstituted emulsions (RE) displayed unimodal distribution, except Mx+Prot and Mx+Prot+Muc, which were bimodal. The lowest and highest D[4,3] values of E and RE were those of NaCas+Lac+Muc and NaCasLac (~0,3µm), and Mx+Prot and Mx+Prot+Muc (~19,0µm), respectively. The dispersibility of microcapsules was assessed following the change in droplet obscuration as a function of time (5min). The Ranciamt test revealed the highest induction time for microcapsules with NaCas+Mx+Muc and NaCas+Mx (~13h), being this value about six times higher than that of bulk oil (~2h).

3. **Unsaturated Lipids-facilitated Lymphatic Transport of Lipophilic Bioactive Component: Oxidized vs. Unoxidized.** M. Yao[1], F. Kitamura[2], D.J. McClements[1,3], and H. Xiao[1], [1]University of Massachusetts Amherst, USA, [2]Tokyo University of Marine Science and Technology, Japan, [3]King Abdulaziz University, Saudi Arabia.

One of the most effective ways to enhance the bioavailability of highly lipophilic food components is to facilitate their chylomicron-based lymphatic transport by oral administration with dietary lipids. However, lipids especially the ones with polyunsaturated long chain fatty acids (PUFA) are very susceptible to oxidation. Ingestion of oxidized lipids is associated with all kinds of health risk: diabetes, tumor development and atherosclerosis. Meanwhile, the oxidation of lipids may affect the absorption of lipophilic bioactive components in foods. In this study, we compared the effect of oxidized and unoxidized PUFA, linoleic acid (LA) on the transport of the highly lipophilic compound 5-hydroxy-6,7,8,4'tetramethoxylflavone (5-DMT) by a Caco-2 cell model. Results turned out that

unoxidized LA improved bioavailability of 5-DMT by stimulating chylomicrons (CMs). Oxidized LA also showed an effect of improving transport of 5-DMT. However, it significantly affected the morphology of Caco-2 monolayer especially the tight junction. Accordingly, the transport pathway could be altered compared to the unoxidized LA, which will ultimately influence the distribution and metabolism fate of lipophilic components in the human body.

4. **Development of New Methods for Analyzing Lipid Oxidation: HPLC-DNPH Analyses of Carbonyl Oxidation Products.** L. Yao and K.M. Schaich, Rutgers University, USA.

Hydroperoxides from lipid oxidation decompose to form carbonyl secondary oxidation products, which must be measured with primary products to determine degree of oxidation accurately. Measuring non-volatile carbonyls qualitatively and quantitatively is challenging. A stable HPLC-DNPH (2,4-dinitrophenylhydrazine) assay combined with MS detection has been developed to identify and quantitate individual and total monomers and core soluble carbonyl oxidation products. Carbonyl standards derivatized by DNPH were used to optimize elution conditions with acetonitrile: isopropanol:water gradients, C18 and C30 columns, and reversed phase HPLC with diode array detection at 360nm. Gradients were first optimized for monomers using carbonyl standards of different chain lengths and saturation, then extended to elute and separate in sequence monomers, phospholipids, and acylglycerols. The method was applied to detect carbonyls in oxidized trilinolein, commercial oils, and lipid extracts. Carbonyl monomers and core aldehydes in trilinolein were identified by LC-MS/MS Q-TOF. The optical response of DNPH derivatives decreased with carbonyl chain length, so a method using average regression equations for three chain length ranges is proposed. The method can be used for both mechanistic studies and general monitoring of lipid oxidation

5. **Effects of Key Ingredients in Different Peanut Varieties on Oil Stability.** H.Z. Liu, Q. Wang*, L. Liu, Y. Yang, A.M. Shi and H. Hu, J.S. Zhang, Chinese Academy of Agriculture Sciences, China.

The aim of this study is to investigate the key ingredients of peanuts related with the oil qualities and their effects on the peanut oil stabilities. The stabilities of the oil got from 45 different peanut varieties and the fatty acid compositions and their proportions in different peanuts were examined. Then the correlation analysis showed induction time (OSI) was significantly negative correlated with linoleic acid ($P<0.01$, $r=-0.57$) and PUFA ($P<0.01$, $r=-0.50$) while it was significantly positive correlated with O/L ($P<0.01$, $r=0.47$). Moreover, the contents of vitamin E, campsterol, stigmasterol, β-sitosterol and squalene in these 45 peanut varieties were also studied and the correlation analysis indicated that these endogenous antioxidants in peanuts had little impacts on peanut oil stability. By supervised principal component analysis, a relationship model between key ingredients of peanuts and the standardized peanut oil quality indexes (Y) was set up as follows: Y=-0.412547×Lipid+2.560138×O/L-0.618986×PUFA. This model was further verified by another 11 peanut varieties and the correlation coefficient between original value and calculated value was 0.700. Based on this model, the evaluation methodology and standards of peanuts quality could be got by cluster analysis for estimating the suitability of new peanut varieties for oil processing scientifically.

6. **Role of the Medium in the Inhibited Oxidation of Lipid Membranes Models.** S. Lednev[1], A. Sirick[2], and E. Pliss[1], [1]P.G. Demidov Yaroslavl State University, Russia, [2]Russian Academy of Sciences, Russia.

The use of antioxidants to protect cell membranes is closely related to the effect of the medium. Therefore, we should make a point to the polar effects to establish the detailed mechanism of inhibited oxidation radical reactions proceeding in biological systems involving natural surfactants (phospholipids) that serves as cell membranes' model.

The results of systematic study of specific and nonspecific solvation influence on the inhibited oxidation of unsaturated compounds (methyl linoleate, linoleic acid, methyl methacrylate and styrene), simulating lipid membranes fragments, are presented in this work for the first time. Phenols (PhOH), aromatic amines (AmH), stable nitroxyl radicals (>NO$^{\bullet}$), and the corresponding hydroxylamines (>NOH) were used as antioxidants. The reaction was studied both in different polarity solvents and in phosphate buffer. The rate constants of $RO_2^{\bullet}$+InH→ROOH+In$^{\bullet}$ reaction (InH: PhOH, AmH or >NOH; In$^{\bullet}$: PhO$^{\bullet}$, Am$^{\bullet}$ or >NO$^{\bullet}$) and also the complex formation equilibrium constants were determined using a combination of microvolumetry, IR and NMR spectroscopy methods. The data

obtained suggest that, depending on solvent and substrate's polarity, the electrostatic effects dominates upon the chain propagation reactions, while the values of linear chain termination rate constants reflects the combined influence of both specific and nonspecific solvation effects.

7. **Chain Oxidation of Methyl Linoleate as Kinetic Model of Lipid Peroxidation: A Role of Nitroxyl Radicals in Establishing the Mechanism of Process.** E. Pliss[1], A. Rusakov[1], R. Pliss*[1], and D. Loshadkin[2], [1]P.G. Demidov Yaroslavl State University, Russia, [2]Yaroslavl State Technical University, Russia.

Methyl Linoleate (LH) is widely used as a kinetic model of lipid Peroxidation. An analysis of experimental data is complicated: 1. Chain propagation and termination can undergo intra- and inter-micellar processes. 2. Chains terminate via mixed quadratic and linear mechanisms. While quadratic termination is widely known, the mechanism of linear termination is still unclear. This paper provides the results of studying radical-chain LH oxidation in solutions and micelles in the mode of noninhibited process and in the presence of various stable nitroxyl radicals (>NO$^\bullet$). Several methods were used: oxygen concentration monitoring, ESR, GC, kinetic modeling, quantum-chemical analysis.

It is for the first time established that a cyclic mechanism of chain termination at >NO$^\bullet$ was observed during LH oxidation in solutions and in micelles. The reason of cyclic chain termination in solutions is alternation of $LO_2^\bullet$ + >NO$^\bullet$ → LOOH + >NOH and $LO_2^\bullet$ + >NOH → LOOH + >NO$^\bullet$. First, this process allows determining reasons of linear chain termination during noninhibited oxidation in micelles: $HO_2^\bullet$ have higher mobility than $LO_2^\bullet$. Second, it explains that multiple chain termination at >NO$^\bullet$ is caused by alteration of $HO_2^\bullet$ + >NO$^\bullet$ → H_2O_2 + >NOH and $HO_2^\bullet$ + >NOH → H_2O_2 + >NO$^\bullet$.

8. **Nitroxyl Radicals as a Inhibitors of Oxidation of Methyl Linoleate in Micelles.** I. Tikhonov[1], L. Borodin[2], E. Pliss[2], and V. Sen*[1], [1]Russian Academy of Sciences, Russia, [2]P.G. Demidov Yaroslavl State University, Russia.

Nitroxyl radicals at submillimolar concentrations exhibit antioxidant effect on biomolecules as shown in various studies. Typically, these studies were performed on complex biological objects, so the mechanism of the process remained unclarified. In this work we study the oxidation of methyl linoleate in Triton X-100 micelles, inhibited by nitroxyl radicals. The kinetics of oxygen uptake was studied using Clark electrode technique, and the kinetics of nitroxyl radicals consumption was studied using EPR spectroscopy. It was found that nitroxyl radical consumption during the inhibited oxidation proceeds nonstoichiometrically. Measured values of the inhibition coefficient were in range of 3-5, i.e. substantially higher than the theoretical value of 1. It was established that hydrophilic nitroxyl radicals inhibit oxidation to a lesser extent than hydrophobic radicals at fixed concentration. Such an effect is apparently due to differences in the distribution coefficients in the system micelles/water, whereby the local concentration of the hydrophobic nitroxyl radicals in the micelle is higher than of hydrophilic. Multiple chain termination during the oxidation of methyl linoleate in micelles can be explained either by the reaction of nitroxyl radicals with peroxide radicals of methyl linoleate or by hydroperoxide radical formation.

9. **Antioxidative Capacity of Rosemary Loaded Oil-in-Water Emulsions in Cooked Sausages.** M. Erdmann[1,2], R. Lautenschlaeger[1], and J. Weiss[2], [1]Max Rubner-Institut, Germany, [2]University of Hohenheim, Germany.

Lipid oxidation is known as a relevant quality reducing reaction in foods. Therefore, natural antioxidants have been utilized to protect bulk oils and emulsions. Due to high levels of carnosic acid and carnosol, rosemary extract is one of the most common plant extracts used in the food industry. However, the application of plant extracts to foods is still challenging due to their low water solubility. For this reason, emulsions can be used as colloidal delivery systems. We hypothesize that the use of nanoemulsions as delivery systems may be more potential in terms of antioxidative activity due to high volume-to-surface ratios. Therefore, differently sized oil-in-water emulsions stabilized by Tween 80 (2% w/w, pH 5) were fabricated and loaded with rosemary extract (10000ppm). The antioxidative capacity of all emulsions (d_{43} = 180 – 6000 nm) was tested against a cooked sausage containing a fish oil-in-water emulsion (2% w/w Tween 80, pH 5; d_{43} = 140nm). The oxidation was followed by measuring primary and secondary oxidation products. Our results indicate that the droplet size does not affect the formation of oxidation products in cooked sausages rich in n3-fatty acids. It appears that the chemical potential difference arising from

concentration differences between the oils drive mass exchange.

10. **Plant Raw Materials Against Linseed Oil Oxidation.** O. Shadyro, A. Sosnovskaya, I. Edimecheva, and A.G. Lisovskaya*, Belarusian State University, Belarus.

The efficiency of using medicinal and aromatic plants (sage, St. John's wort, thyme, rose hips, cumin, ginger, turmeric, clove), as well as haricot beans, soybeans and their compositions to improve the oxidative stability of linseed oil was studied. Based on the kinetics of primary and secondary oxidation products accumulation in linseed oil and its oily plant extracts it was shown that addition of soya, haricot beans, sage and cumin most effectively inhibits the process of linseed oil oxidative damage. The stabilization methods and technology for edible linseed oil production with the use of new natural stabilizing compositions based on legumes that allows effectively inhibit the oxidation of linseed oil by increasing its shelf life to 12-15 months without changing the consumer properties have been developed. In addition to high efficiency developed stabilizing compositions also possess a number of other advantages, which include safety, availability, and low cost of components, ease of its preparation. The full-scale production of oxidation-resistant edible linseed oil and biologically active dietary supplements on its basis was organized.

11. **Characterizing the Kinetics of Individual Triglycerides and Lipid Oxidation Products in Frying Oils via Mass Spectrometry-based Chemometric Analysis.** L. Wang, A. Csallany, and C. Chen*, University of Minnesota, USA.

Frying-induced chemical reactions in vegetable cooking oils have been extensively studied, but the kinetics of these events are not well defined. In this study, lipid extracts of French fries from multiple fast food restaurants were compared with soybean, corn, canola oils through high-resolution liquid chromatography-mass spectrometry (LC-MS) analysis and multivariate analysis. After similar profiles of triglycerides between several French fry samples and heated soybean oil (HSO) were observed, the kinetics of degrading triglycerides and forming lipid oxidation products in HSO during 6 h of heating at 185^{o}C were investigated. The degradation of individual triglycerides was positively correlated to the carbon chain length and unsaturation level of their fatty acid contents, and the increase of 13-hydroperoxyoctadecadienoic acid and 13-oxotridecadienoic acid in triglycerides mainly occurred after 30min of heating. Compared to the gradual increase of many alkenal LOPs, the formation of 4-hydroxynonenal accelerated greatly after 1h of heating while the level of 2-heptadienal decreased after 30min. Overall, chemometrics-based kinetic analysis could facilitate the establishment of individual triglycerides and LOPs as specific status indicators of frying oils.

12. **Unusual Kinetic Isotope Effects of Deuterium Reinforced Polyunsaturated Fatty Acids in Tocopherol-mediated Free Radical Chain Oxidations.** C. Lamberson[1], L. Xu[1], J.R. Montenegro-Burke[1], H. Muchalski[1], V. Shmanai[4], A. Bekish[5], J. McLean[1], C. Clarke[2], M. Shchepinov[3], and N. Porter[1], [1]Vanderbilt University, USA, [2]University of California, Los Angeles, USA, [3]Retrotope, Inc., USA, [4]National Academy of Sciences of Belarus, Belarus, [5]Belarusian State University, Belarus.

The *bis*-allylic –CH_2- groups in polyunsaturated fatty acids (PUFAs) are susceptible to hydrogen atom abstraction, making PUFAs prone to free radical-mediated peroxidation. A recent strategy to diminish lipid peroxidation *in vivo* is based on substituting *bis*-allylic hydrogen atoms with deuterium. Previous studies have shown these deuterated PUFAs (D-PUFAs) undergo peroxidation in solution with propagation rate constants 10-fold less than the natural fatty acids. This isotope effect falls outside of the range of k_H/k_D (<7) which has been reported for other H(D) atom transfers from carbon to peroxyl radicals. Recently, we have carried out tocopherol-mediated oxidations of several D-PUFAs and measured isotope effects ranging from 23 to 36 using LC-MS and HRMS techniques. The H-atom transfer from the *bis*-allylic –CH_2- center to the tocopheryl radical is the rate-determining step in *tocopherol-mediated peroxidation* (TMP) of lipids in human low-density lipoproteins (LDL), a process which has been linked to coronary artery disease. These unexpectedly large kinetic isotope effects for the tocopherol-mediated oxidation of linoleic and linolenic acid suggest that H-atom tunneling makes this process favorable and plays a significant role in the oxidative modification of human LDL.

13. **Lipid and Fatty Acid Profile of Edible Macroalgae.** C.G. Costa, A.S.G. Costa*, T.J.R. Fernandes, F.B. Pimentel, R.C. Alves, A.C. Alves, and M.B.P.P. Oliveira, University of Porto, Portugal.

Macroalgae (seaweed) are an outstanding example of marine biodiversity and an excellent

source of a wide number of chemical compounds with health benefits. Nowadays, the consumption of macroalgae has increased due to its nutritional value namely fiber content, protein and fat profiles. Seaweeds have low energy value, mainly due to their reduced lipid content.

This study aims to evaluate the lipid fraction of the most consumed six species of seaweed available in Portuguese market. Fat content was determined by Soxhlet procedure and the fatty acids profile was evaluated by GC-FID.

The total fat was less than 1g/100g of dry weight in all samples. Eighteen fatty acids were identified. Unsaturated fatty acids (MUFA, monounsaturated and PUFA, polyunsaturated) ranged from 50% to 67%. Palmitic acid (C16:0) was the predominant saturated fatty acid (SFA) between 14% and 32%; oleic acid (C18:1 n-9) was the most abundant MUFA reaching 25%, and the predominant PUFAs arachidonic acid (C20:4 n-6) and eicosapentaenoic acid (C20:5, n-3) ranged from 5% to 26% and 4% to 36%, respectively.

The results show macroalgae as interesting sources of omega 6 and omega 3 fatty acids. Their consumption could improve consumers' health and wellbeing.

14. **The Unsaturated Fatty Acid Composition of Vegetable Oil Affects Odor Production Formed During Heating.** S. Koishi[1], S. Nakajima[1], and Y. Endo[2], [1]Tsuno Food Industrial Co., Ltd., Japan, [2]Tokyo University of Technology, Japan.

The amount of odor components (acrolein, propanal and hexanal) formed during heating vegetable oils was determined by using gas chromatography. Various vegetable oils (rice bran oil, corn oil, sunflower oil, palm oil, rapeseed oil, perilla oil and soybean oil) which are different in unsaturated fatty acid composition were heated at 180 degrees Celsius for 360 minutes. The amount of acrolein and propanal were correlated with linolenic acid contents in the vegetable oils. On the other hand, the amount of hexanal was correlated with linoleic acid contents among vegetable oils which have comparable amount of linolenic acid. It suggested that those odor components were mainly formed from linoleic acid and linolenic acid, and the reactions occur competitively.

15. **Radical Polymerization Initiated by Hydroperoxide Decomposition on the Surface of Heterogeneous Catalysts.** M.P. Berezin, O.T. Kasaikina, D.A. Krugovov, and E.A. Mengele, Russian Academy of Sciences, Russia.

Cationic surfactants are found to form mixed micelles together with amphiphilic hydroperoxides (LOOH) and catalyse decomposition of hydroperoxides into free radicals. Heterogeneous catalysts for radical generation were prepared by adsorption of CTAB (cetyltrimethylammonium bromide) on montmorillonite (M1), microcrystalline cellulose (Cel1), and chitosan (Chi1). By means of microcalorimetry, the rates of styrene polymerization initiated by cumene hydroperoxide combined with prepared colloid catalysts were determined. Unlike a less adsorption of CTAB on cellulose and chitosan, the polymerization rates with these catalysts were found to be in several times higher than that with M1. The catalytic activities of M1, Cel1, and Chi1 were tested in the model reaction of natural hydrocarbon limonene oxidation. The rates of free radical generation via catalytic limonene hydroperoxide decomposition decrease in the sequence: Cel1 > M1 >Chi1. The increase of catalytic effect of cationic surfactant on the cellulose surface and the role of hydroperoxide nature in colloid catalytic system are discussed.

16. **Development of Iron Chelating Poly(ethylene terephthalate) Packaging for Inhibiting Lipid Oxidation in Oil-in-Water Emulsions.** D.R. Johnson[1], F. Tian[1], M.J. Roman[1], E.A. Decker[1,2], and J.M. Goddard[1], [1]University of Massachusetts Amherst, USA, [2]King Abdulaziz University, Saudi Arabia.

Foods such as bulk oils, salad dressings, and nutritionally fortified beverages that are susceptible to oxidative degradation are often packaged in poly(ethylene terephthalate) (PET) bottles. In the present work, the ability to graft poly(hydroxamic acid) (PHA) metal chelating moieties from the surface of PET was investigated. Biomimetic PHA groups were grafted in a two-step UV-induced process without the use of a photoinitiator. Colorimetric (ferrozine) and inductively coupled plasma mass spectroscopy (ICP-MS) assays demonstrated the ability of PET-*g*-PHA to chelate iron in a low pH (3.0) environment containing a competitive metal chelator (citric acid). Lipid oxidation studies showed the antioxidant activity of PET-*g*-PHA films in inhibiting iron-promoted oxidation in an acidified O/W emulsion model system (pH 3.0). Particle size and Z-potential analysis

indicated that the addition of PET-*g*-PHA films did not impact the physical stability of the emulsion system. This work suggests that biomimetic chelating moieties can be grafted from PET and effectively inhibit iron-promoted degradation reactions.

17. **Microalgae Lipids Extraction Using Corona Discharge Plasma in the Biodiesel Production.** E.H.S. Moecke[2,1], A.P. Matos[1], R. Feller[1], M.M. Machado[1,2], and A.L.V. Cubas[2], [1]Universidade Federal de Santa Catarina, Brazil, [2]Universidade do Sul de Santa Catarina, Brazil.

New sources of raw material are needed to cover the current demand for biofuels, which has been the focus of many researches using microalgae as a source of lipids. Several methodologies have been applied to the algal biomass for intracellular lipids extraction. Therefore, the objective of this paper is to evaluate the ability of extracting lipids from biomass *Nannochlorospsis sp.* when placed in contact with the cold plasma; and the quantification and qualification of the fatty acids present in the lipid extract of the biomass after plasma application. The concentration of lipids obtained from algal biomass ranged from 17.5 to 3,9% in the different treatments. Regarding to fatty acids, in treatment without plasma, it was found that biomass *Nannochlorospsis sp.* is a source of poly-unsaturated fatty acids, especially eicosapentaenoic acid EPA C20: 5Ω3. With application of plasma was found higher levels of monounsaturated fatty acids (palmitoleic acid C16:1) and saturated (palmitic acid C16: 0) in all treatments carried out.

18. **Stability of Oxidative Products in Quinoa (*Chenopodium quinoa*) During Accelerated Aging.** A.K. Anderson, Kuwait University, Kuwait.

The oxidative stability of lipids in processed quinoa was investigated in this study. Ground quinoa was subjected to accelerated aging for 30 days at 25, 35, 45, and 55°C. Three samples were removed from each temperature treatment every 3 days. Free fatty acids, conjugated diene hydroperoxides, and hexanal were used as indicators of lipid oxidation. Free fatty acids generally showed an increasing trend for the samples kept at 45 and 55°C over the period of the study, and a steady increase in conjugated diene hydroperoxides was observed at all four temperature treatments up to a maximum on day 9. However, all hexanal values dropped slightly at day 3, and only minor fluctuations were observed over the 30-day sampling period for the 45 and 55°C samples. Storage time and temperature had significant effects ($p \leq 0.05$) on all three parameters, while the interaction between storage time and temperature was not significant for conjugated diene hydroperoxides produced. The results from these tests suggest that quinoa lipids are stable for the period of time studied. With vitamin E as a naturally antioxidant occurring abundantly in quinoa, the potential for quinoa to be a new oilseed could be enhanced.

19. **Oxidative Quality of Soybean/Beef-tallow Biodiesel Blends During a Long-term Storage.** G. Pereira, L. Ferreira, and D. Barrera-Arellano*, University of Campinas, Brazil.

The purpose of this work was to evaluate the oxidative quality of soybean/beef-tallow biodiesel blends under conditions similar to real storage. 13Kg of soybean/beef-tallow biodiesel samples (SB) (70/30 and 50/50, w/w) were stored into carbon steel tanks with capacity of 20L during 400 days. Soybean biodiesel (SO) was also used for comparison. Aliquots were collected in different time intervals and analyzed *via* oxidative stability and physicochemical parameters. Fresh biodiesel samples showed oxidative stability of 6.4, 8.4, and 10.3h for SO, SB 70/30, and SB 50/50, respectively. Therefore, the samples containing beef-tallow biodiesel met the limits proposed by EN 14214 (min. 8h). The oxidative stability of all biodiesel samples reduced during the storage. Additionally, the end of the stability of SO and SB 70/30 occurred between 215-250 and 300-350 days, respectively. In contrast, the SB (50/50) sample showed oxidative stability of 1.5h at 400 days of storage. Similar to the results mentioned earlier, the SB 70/30 and SB 50/50 samples showed lower evolution in the peroxide value, viscosity, and polar compounds as well as lower losses in natural tocopherols during the storage. In conclusion, the blending of soybean and beef-tallow biodiesel (70/30 or 50/50) is a good alternative to improve the oxidative stability of this biofuel.