Abstracts

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to obtain high oleic oils has led to better acceptance of these oils as lubricants. We have successfully expressed a hydroxylase gene in a high oleic canola background. The combination of a high oleic background with a hydroxy fatty acid produced an oil with properties that improve further on high oleic oils. The presence of the hydroxy group provides improved lubricity. This technology will allow us to create oils with varying hydroxy fatty acid content depending on the application. These applications can range from use in lubricants, as chemical feedstocks and reactive components in polymers.

Genetic Modification of Soybean Oil for Food and Industrial Uses. W. Fehr, Iowa State University, USA. *Contact:* Walter Fehr, Iowa State University, 1212 Agronomy Hall, Ames, Iowa 50011, USA.

Genetic modification of soybean oil has been achieved by non-transgenic and transgenic methods. Conventional soybean oil has approximately 12% palmitic acid, 4% stearic acid, 27% oleic acid, 50% linoleic acid, and 7% linolenic acid. Genetic variants have been developed that range from 3.5 to 40% palmitic, > 30% stearic, >80% oleic, and as low as 1% linolenic. A low-saturate oil with 3.5% palmitic and normal stearic has been sold commercially since 1997. An oil with about 2.5% linolenic was used commercially for a few years, but is no longer produced. Modified soybean oil with 80% oleic is used commercially on a small scale. The adoption of a modified oil is dependent on the development of high-yielding cultivars that can be grown effectively by farmers, the costs of identity preservation associated with producing a specialty oil, and the demand for the product. Soybean genotypes with elevated palmitic and stearic have problems with seed germination and lower seed yield, which make it difficult to develop cultivars that could be grown successfully by farmers. The costs of identity preservation of a modified oil must be passed on to the end users. End users are likely to have oils from other crops that can be used in their products, which sets an upper limit on identity preservation costs that can be incurred and may prevent a modified soybean oil from becoming a commercial reality. For example, the market for low-saturated soybean oil has been limited because of the availability of commodity canola oil that does not incur any identity preservation costs. The two modified soybean oils with the greatest market potential at the present time have 80% oleic or 1% linolenic. Both oils are intended to be an alternative to hydrogenation. Evaluations currently underway by companies involved with food and industrial applications will have a major impact on the future of the two oils.

Triacylglycerol-Based Production of Environmentally Benign, Value-Added Polymers and Surfactants. R.D. Ashby, D.K.Y Solaiman, A. Nuñez and T.A. Foglia, USDA, ARS, ERRC, USA. *Contact:* Richard Ashby, USDA, ARS, ERRC, 600 E. Mermaid Ln., Wyndmoor, Pennsylvania 19038, USA.

Animal fats and vegetable oils are derived from renewable resources and can be utilized as carbon substrates in fermentation processes designed to produce value-added materials. Many species of bacteria and yeast are able to utilize triacylglycerols (TAGs) or their components (free fatty acids, FFA, and glycerol) to synthesize biopolyesters (polyhydroxyalkanotes; PHAs), and biosurfactants (sophorolipids; SLs). These biobased products could replace their synthetic equivalents provided their production costs can be minimized. Presently, there are over 100 different structural variations of PHA. These variations depend on the genetic makeup of the bacteria and the carbon substrate provided to the organism. By utilizing different bacterial strains we have produced from TAGs, FFAs and glycerol both short-chain PHA (scl-PHA), the most common of which is poly 3-hydroxybutyrate (PHB), a semicrystalline thermoplastic, and the amorphous medium-chain PHA (mcl-PHA), which contains monomers of 3-hydroxyalka(e)noates with 6 to 14 carbon atoms and exhibits elastomeric or adhesive-like properties. We have further modified the properties of the polymers by molar mass regulation, formation of natural polymer blends and crosslink formation through gamma irradiation and epoxidation and aging. SLs are amphipathic molecules produced by the yeast *Candida bombicola* from a number of TAGs and FFAs. Their primary structure is a disaccharide (sophorose; 2′-O-β-D-glucopyranosyl-β-D-glucopyranose) with a fatty acid (oleic acid is preferred) that can be in its free acid form attached at the 1ſ position or lactonized between the 1′ and 4′ positions of the glucose rings. These molecules are biosynthesized in acetylated or nonacetylated forms and are generally synthesized as mixtures containing up to 12 different compounds. Recently, we were successful in utilizing fatty acid methyl esters (FAMEs) and the waste stream from biodiesel production to produce SLs with increased ratios of FAME in their side chains. This allowed further structural modifications. In summary, our research efforts have demonstrated the possibility of synthesizing and modifying biomaterials using TAGs as feedstocks.

Progress in Moving from Research to Commercial Production of Cuphea in the U.S. R.W. Gesch, F. Forcella, B.S. Sharratt, A. Olness and D. Archer, USDA, ARS, NCSCRL, USA. *Contact:* Russ Gesch, USDA, ARS, NCSCRL, 803 Iowa Ave., Morris, MN 56267, USA.

Several species of Cuphea (*Lythraceae*) are unique among plants adapted to temperate climates in that they emphasize the synthesis and storage of small and medium-chain triglycerides in their seed. Currently, no crops are grown in the U.S. that meet demands of the chemical manufacturing industry for small and medium-chain oils. During the past decade, success was achieved in developing semi-domesticated lines of cuphea from crossing *C. viscosissima* with *C. lanceolata*. However, until recently, little was known about the extent of their agronomic potential, or best management practices for their production. Our work with cuphea focuses on developing management practices for production and identifying agronomic and environmental limitations. In addition to the value of its seed oil, cuphea offers a true alternative crop for rotations which are already suffering from lack of diversity. Results show that present cuphea lines (e.g., PSR23 and PSR57) are best suited for production in the northern Midwest region. Likely, this is linked to soil water holding capacity and water use of plants, and seasonal timing of high temperatures, both of which are crucial in the growth and development of cuphea. Planting with a no-till drill in a minimum-residue seedbed has proven successful, although uniform crop establishment remains elusive. Harvesting is still problematic mainly due to low harvest index and seed shattering. Shattering prior to and during the harvest process may account for seed losses as high as 20 to 40%. Late season broadleaf weed control and nutritional requirements of cuphea require further study. While some obstacles to commercialization of cuphea remain, results appear favorable for agronomic production in the near future.

Common Milkweed Production. W. Phippen, Western Illinois University, USA. *Contact:* Winthrop Phippen, Western Illinois University, 1 University Circle, Macomb, IL 61455, USA.

In response to declining commodity prices and the need for crop diversification, a new breeding and production research program has been developed to investigate introducing alternative crops to the Mid-west region. One crop of particular interest is perennial common milkweed (*Asclepias syriaca*) for the production of industrial fibers, oils, latex, and a potent nematicide. The milkweed research program is focused on developing planting strategies, field maintenance guidelines, handling equipment, and materials for value-added product development. Studies to date have focused on planting methods, row spacing densities, effects of coal dust on plant establishment, and herbicide trials. For the plant spacing experiments, data was collected from individual plants regarding pod and stalk biomass after the second year of growth. Average pod weight, total number of pods, and dry stalk biomass per plant increased with greater row spacing while total dry biomass per acre decreased with larger row spacing. Effects of coal dust were found to be not significant at improving: plant emergence, pod formation, or total number of stalks. Herbicides have been identified for controlling all weeds in the second year of production. First year herbicides are still currently being tested. Long-term objectives for the milkweed research program will be focused on improving yields, developing auto-fertile varieties, and developing machinery for handling the milkweed harvest. The program has also begun to generate supplies of milkweed floss, seed, fibers, and biomass for