International jojoba conference

The 7th International Conference on Jojoba, "Production, Processing and Utilization of Jojoba," will be held Jan. 17–22, 1988, at the Hyatt Regency Hotel in Phoenix, Arizona. The conference will feature 34 technical speakers and approximately 20 poster presentations, in addition to an exhibit and social activities.

The conference is cosponsored by the American Oil Chemists' Society and the Jojoba Growers' Association (JGA).

Participating organizations include the American Chemical Society, the Asociacion Latinoamericana de Jojoba, the Cosmetic, Toiletry and Fragrance Association, the Institute of Food Technologists and the Jojoba Association of Australia.

A keynote talk on "Horizons for

Program at a glance

Sunday, January 17, 1988

2:00 p.m.– 7:00 p.m.	Registration, Hyatt Regency Hotel, Phoenix Exhibits open
5:30 p.m.– 7:00 p.m.	All-Conference Opening Mixer, Hyatt Regency Hotel, Phoenix

Monday, January 18, 1988

7:30 a.m.– 5:00 p.m.	Registration, Hyatt Regency Hotel, Phoenix
8:30 a.m.– 9:30 a.m.	Welcome
9:15 a.m.– 5:15 p.m.	Exhibits open
9:30 a.m.–10:00 a.m.	Break
10:00 a.m.–11:00 a.m.	Keynote Address
11:00 a.m.–Noon	Session on Plant Physiology
Noon– 1:30 p.m.	Lunch Break
1:30 p.m.– 3:00 p.m.	Plant Physiology (cont'd)
3:00 p.m.– 3:30 p.m.	Break
3:30 p.m.– 6:00 p.m.	Session on Agronomy
7:00 p.m.– 8:30 p.m.	Welcoming reception at the Heard Museum sponsored by the Jojoba Growers' Association

Tuesday, January 19, 1988

7:30 a.m.– 5:00 p.m.	Registration
8:00 a.m.– 9:30 a.m.	Agronomy (cont'd)
9:15 a.m.– 5:15 p.m.	Exhibits open
9:30 a.m.–10:00 a.m.	Break
10:00 a.m.–Noon	Discussion Session
Noon– 1:30 p.m.	Lunch
1:30 p.m.– 3:00 p.m.	Session on Processing, Economics & Marketing
3:00 p.m.– 3:30 p.m.	Break
3:30 p.m.– 5:00 p.m.	Processing, Economics & Marketing (cont'd)
5:00 p.m.– 6:00 p.m.	Discussion Session

Wednesday, January 20, 1988

7:30 a.m.– 8:00 a.m.	Registration
8:00 a.m.	Departure for the all-day field trip to jojoba production farms and processing plant

Thursday, January 21, 1988

7:30 a.m.– 5:00 p.m.	Registration
8:00 a.m.– 9:30 a.m.	Session on Basic Chemistry
9:15 a.m.– 3:30 p.m.	Exhibits open
9:30 a.m.–10:00 a.m.	Break
10:00 a.m.–Noon	Basic Chemistry (cont'd)
Noon–1:30 p.m.	Lunch
1:30 p.m.– 3:00 p.m.	Session on Cosmetics and Pharmaceutical Uses
3:00 p.m.– 3:30 p.m.	Break
3:30 p.m.– 4:30 p.m.	Cosmetics and Pharmaceutical Uses (cont'd)
4:30 p.m.– 6:00 p.m.	Discussion Session
7:00 p.m.	Old West Casino Night

Friday, January 22, 1988

7:30 a.m.–Noon	Registration
8:00 a.m.– 9:30 a.m.	Session on Food and Feed Uses of Jojoba Products
9:30 a.m.–10:00 a.m.	Break
10:00 a.m.–11:00 a.m.	Food and Feed Uses of Jojoba Products (cont'd)
11:00 a.m.–Noon	Discussion
Noon	Synopsis and Adjournment

Note: All technical sessions will be held in the Hyatt Regency, Phoenix.

New Agricultural Products" will be presented Monday, Jan. 18, 1988, by George Dunlop, assistant secretary of natural resources and environment for the U.S. Department of Agriculture.

Welcoming participants to the conference will be Carole A. Whittaker, general chairperson; AOCS President Robert Hastert, Hal C. Purcell of the Jojoba Growers' Association and U.S. Senator Dennis DeConcino of Arizona. The technical program will feature sessions on plant physiology, agronomy, basic chemistry and industrial uses, and food and feed uses of jojoba products. All plenary talks will be presented in English, although simultaneous translation into Spanish will be available.

All technical registrants will receive a conference proceedings, which will be published in mid-1988.

Exhibits will be open Sunday, 2–7 p.m., and Monday and Tuesday from 9:15 a.m. until 5:15 p.m. They will be closed Wednesday due to the field trip but will be open Thursday from 9:15 a.m. until 3:30 p.m.

Social events

The conference will begin with an opening mixer Sunday, Jan. 17, 1988, from 5:30–7 p.m. at the Hyatt Regency, Phoenix, in the conference registration area/exhibit hall.

On Monday evening, Jan. 18, the Jojoba Growers' Association and other representatives of the jojoba industry will host a cocktail party from 6–7:30 p.m. at the Heard Museum, noted for its premier presentation of the heritage and art of the Southwest.

On Wednesday, Jan. 20, busses will depart from the Hyatt Regency, Phoenix, at 8 a.m. for an all-day field trip to the jojoba plantations. Following the plantation tours, a Western-style barbecue will be served before returning to Phoenix.

On Thursday, Jan. 21, beginning at 7 p.m., an "Old West Casino Night" will include dancing, casino games and other entertainment in addition to a saloon bar and buffet dinner.

Casual attire is suggested for the Sunday evening opening mixer and the Thursday evening "Old West" event. Business attire is suggested for the Monday reception at the Heard Museum. Comfortable clothes appropriate for the weather are recommended for the Wednesday field trip.

Guests' Program

All registrants for the Guests' Program are invited to participate in the all-conference social events. The Wednesday all-day field trip is not included in the Guests' Program, but those wishing to participate may purchase tickets at the conference registration desk.

The Guests' Program will highlight cultural, historical and geographical interests of Phoenix and Central Arizona.

The Monday program on Indian prehistory and art will teach guests how to assess the quality of Indian jewelry, pottery, baskets and rugs. Guests then will be served a luncheon of dishes unique to Southwestern cuisine prepared for them in a special demonstration session. Busses will leave at 8 a.m. and are expected to return to the hotel by 1 p.m.

A narrated bus tour on Tuesday will depart at 8 a.m. and take guests to Montezuma's Castle, the best preserved prehistoric cliff dwelling in the Southwest, and on to the Oak Creek Canyon and Sedona. After lunch, there will be time to visit art galleries or to shop. Busses are scheduled to return by 5 p.m.

The Thursday program, to begin at 8 a.m., will include a tour of an Arabian horse ranch and a drive through Arizona's native desert on the way to visit the Southwest Studios, Hovegard Mansion, Boulders Resort and Giant Sun Dial. There will be time for shopping at the specialty shops in Spanish Village before returning to Phoenix at approximately 5 p.m.

Exhibitors

An exposition of suppliers and representatives of the jojoba industry will be held in conjunction with the 7th International Conference on Jojoba and Its Uses in Phoenix. Firms that had reserved exhibit space (booth number in parentheses) as of mid-November include the following:

Asociacion Latinoamericana de Jojoba, Lafinur 3200, #4, A-1425 Buenos Aires, Argentina (10). ALAJO is a nonprofit organization of Latin American jojoba growers actively promoting jojoba development in the arid areas. The exhibit will provide information regarding existing jojoba plantations, potential suitable areas and the advantages of growing jojoba in Latin America.

Associated Jojoba Processors Inc., 2201 E. Camelback Rd., Suite 220B, Phoenix, AZ 85016, USA (3 and 4). Associated Jojoba Processors Inc. is in the final phase of constructing a jojoba processing facility in Arizona's Hyder Valley. The facility will operate a continual-flow cold press and solvent extraction process with capacity to process 30 tons of seed per day. The company will custom-process crops for jojoba farms or will purchase entire crops to process for the company's account. The new facility will provide jojoba oil users with small or large amounts of quality oil on an individual-purchase basis or under long-term contract. The company's goal is to provide a dependable, long-term source of jojoba oil to industry. The controlling shareholder of the company is Associated Jojoba Industries Inc., the developer of one of the industry's largest jojoba plantations.

Desert King-JMC Ltd., 3802 Main St., Chula Vista, CA 92011, USA (6 and 7). A display of jojoba production facilities operated by Desert King-JMC, including large commercial plantations and the world's largest jojoba oil processing plant, will be exhibited. Jojoba product samples and information also will be distributed.

Desert Whale Jojoba Co. Inc., PO Box 41594, Tucson, AZ 85717, USA (28). This exhibit will feature jojoba oil and waxes, including solvent-extracted, hydrogenated and sulfurized jojoba oil, and information on jojoba oil chemistry and applications. As a new service, Desert Whale Jojoba also will provide

De Smet U.S.A. Corp., 2839 Paces Ferry Rd., Suite 640, Atlanta, GA 30339, USA (29). De Smet specializes in designing and supplying processes and machinery for the agro and food industries, with special emphasis on oilseed crushing and vegetable oil refining processes.

Farmland Oil Purchasing Corp., 1802 W. Grand Rd. 110-42, Tucson, AZ 85745, USA (1).

International Lubricants, PO Box 24743, Seattle, WA 98124, USA (32). International Lubricants will display its full line of jojoba-based consumer and industrial products.

Jojoba Growers & Processors Inc., 2267 S. Coconino Dr., Apache Junction, AZ 85220, USA (25 and 26). Jojoba Growers & Processors will display jojoba oil and derivatives, cuttings and illustrations of process technology.

Jojoba Growers Association, 142 Front St., Avila Beach, CA 93424, USA (24). The Jojoba Growers Association, a non-profit organization with international membership, collects and disseminates information on cultural practices, yields, acreage planted, processing, marketing, economics and political issues related to the jojoba industry. Each year it sponsors a cultural practice symposium and an annual meeting and seminar.

KSA Jojoba, 19025 Parthenia St., Northridge, CA 91324, USA (27). KSA Jojoba will display a variety of jojoba-based products, including soaps, lotions, creams, shampoos, facial scrubs, seeds and ointments, along with pure jojoba oil sold in small sample sizes (1/2, 1½, 4 and 8 oz), gallons or drums, Jojoba seeds with instruction booklets also will be available.

Monarch Manufacturing Inc., 13154 County Rd. 140, Salida, CO 81201, USA (16). Monarch Manufacturing manufactures plant bands that can be used as an economical growing and handling container. This type of custom-produced container is designed to allow a greater amount of soil medium per square foot of greenhouse space.

Oliver Mfg./Cunningham & Associates, PO Box 512, Rocky Ford, CO 81067, USA (5).

Pacific Agricultural Services Inc., 4325 W. Shaw Ave., Fresno, CA 93722, USA.

Purcell Jojoba Co., 142 Front St., Avila Beach, CA 93424, USA (18). Leading jojoba cultivars, including Mirov, and yield records will be on display. Representatives will be available to discuss nursery sales, comprehensive new plantation development and management, genetic and cultural practice research and commercial seed production.

Reinartz Machinery, 274 W. Las Flores Dr., Altadena, CA 91001, USA.

Superior Jojoba Oil Co. Inc., PO Box 3008, Tucson, AZ 85702, USA (30 and 31). Superior Jojoba Oil Co. will exhibit state-of-the-art processing techniques used for the extraction of jojoba oil. Also on display will be the latest products and information on future uses of jojoba oil.

The **Tintometer Co.**, 309A McLaws Circle, Williamsburg, VA 23185 USA (2). This exhibit will display color-grading and measuring instruments for edible oils, fats and tallows. Included will be the Lovibond AOCS Color Scale Tintometer, FAC Scale, Gardner Scale, Model E Tintometer, American Oil Tintometer and the latest digital readout Lovibond Automatic Tintometer for Lovibond and AOCS Scale.

Jojoba technical paper abstracts

1

Photosynthesis, Respiration and Growth of Jojoba Throughout the Year.

William R. Feldman, Boyce Thompson Southwestern Arboretum, Superior, AZ 85273, USA

Photosynthesis and respiration constitute the primary productive and consumptive events upon which growth and seed yield are ultimately based. Four aspects of these events will be discussed: (a) diffusion of CO_2 through stomates to the chloroplast, (b) light reactions, (c) carbon reactions, and (d) allocations of carbon gained. Jojoba leaf cuticle is very waxy, and little evaporates through it. Stomates are sunken, with high resistance to water loss even when fully open. Carbon gained is optimized vs. water lost during gas exchange. Photosynthesis is light-saturated at 1000 micro E m-2 and s-1, and rates of net photosynthesis (Pn) and growth are low compared to most crop plants. Maximum Pn rates recorded are 16 mg CO_2 dm-2 and h-1 and normal high rates are about 70% of that value. Optimal temperature for Pn is about 25 C, and Pn drops off markedly below 1 C and above 40 C. Net photosynthesis still occurs under severe water stress but at very low rates. Nutrient and salt stress also reduce rates of Pn. During summer, Pn for irrigated plants is greatest in the morning and least around midday, with some recovery before dusk. Respiration in the dark is correlated with photosynthesis and occurs at rates of 1.5–2.0 mg CO_2dm-2 h-1 in active plants.

Jojoba is a typical C3 plant with respiration in the light normally occurring at a rate of about 25% to 35% that of Pn. Light respiration increases with water stress and may play a part in protecting chloroplasts under stress. Carbon gained during the warm season is stored as starch as temperatures drop and remobilized as sucrose when temperatures rise. Implications of jojoba's photosynthetic and respiratory characteristics as they pertain to its domestication will be discussed.

2

Water Status and Its Control in Jojoba (*Simmondsia chinensis L.*)

Aliza Benzioni, The Institutes for Applied Research, Ben-Gurion University of the Negev, POB 1025, Beer-Sheva 84110, Israel

The water status of jojoba, like that of other plants, is defined by the thermodynamic concept of water potential. The seasonal patterns and diurnal fluctuations of xylem water potential of jojoba have been studied under different irrigation regimes. During the spring, the water potentials usually were relatively high. In the hot season during which growth takes place, even well-irrigated plants suffered from water stress and their water potentials dropped to low values of about -4 MPa at noon. Since these values were below the point of turgor loss, extension growth was prevented for long periods every day. Nonirrigated plants had low water potentials of -3.5 MPa or less even during the summer nights. Their growth was inhibited and their yields were small. Another criterion for determining water status is relative water content, which is linearly related to the water potential. The relative water content of jojoba in the field was between 65–85%. Irrigation, when water was the primary limiting factor, increased growth rates and yields by about 400%.

Jojoba controls both water loss and water absorption by long-term and short-term mechanisms. The long-term adaptation to minimize water loss may be seen in the structure of the leaves. The anatomy of leaves from tissue-cultured plantlets was different from that of leaves from greenhouse seedlings or from tissue-cultured plantlets hardened in a greenhouse. The "tissue-culture" leaves lacked a cuticle and could not control water loss. The short-term responses to fluctuations in evaporative demands are exerted via stomatal control. The stomata responded to a wide range of xylem water potentials, the sensitivity of the stomata to the water potential being greater at high air temperatures. Stomata also were controlled by air and root temperature independently of the water potential. Stomatal conductance was low when soil temperatures were low. This may be the reason for the low leaf permeability and the relatively high water potentials in spring. The effects of water status on growth and yields will be discussed.

3

Leaf Analysis and Nutrient Utilization by Jojoba

Paul J. Eberhardt, IAS Laboratories, Phoenix, AZ, USA

Nutrient utilization patterns of jojoba affect leaf analysis values and must be taken into account when interpreting analyses for nutrient deficiencies. Both nitrogen and sulfur values are affected by the cool season dormancy period. Both nitrogen and sulfur can drop as much as 50% yet still not indicate nutrient deficiency.

Analysis values for leaf tissue also are affected by jojoba seed production. Non-producing jojoba (vegetative) generally requires higher tissue analysis values than seed-producing jojoba for nitrogen, phosphorus and zinc. Calcium, magnesium, manganese and boron are higher for producing jojoba than for non-producing jojoba. Potassium, sulfur, sodium, iron, and copper leaf analyses do not appear to be affected by seed production.

Nutrient sufficiency levels are proposed.

4

The Reproductive Cycle of Jojoba

R.L. Dunstone, CSIRO, Division of Plant Industry, PO Box 1600, Canberra, Australia 2601

Jojoba has evolved a system of sexual reproduction that satisfies the requirements for maintaining a population of this long-lived perennial species in the harsh conditions of its natural habitat. The system is controlled by temperature and water availability in such a way as to allow flowering only in the most favorable season of favorable years.

Flower buds are produced during vegetative growth under warm to hot conditions. The buds can remain dormant for a considerable period during which time they are resistant to frosts.

The flower buds break dormancy only after their chilling requirement has been met. Because the chilling requirement of different jojoba lines varies so much, some are set to open as early as autumn while others are not set until late winter. Water stress during this period will delay or even prevent the breaking of dormancy. The "set to open" condition is marked by incipient bud swelling and, at this stage, buds become susceptible to frosting.

Continued development of the flower bud takes place in response to the accumulated growing degree hours (GDH). The number of GDH necessary to take the bud from the "set to open" condition to the open flower may be modified by the length of the period of over-chilling received during winter.

There are seldom problems with pollination and fruit set in jojoba. Fruit development takes place at a speed determined by the temperature and the availability of water.

5

Selection Criteria and Evaluation Procedures for Jojoba Plant Improvement

Ricardo Ramonet-Razcon, Campo Agricola San Gerardo Sahuaral, Garmendia #137 Nte. Hermosillo, Sonora, Mexico

The importance of jojoba variability for improvement as a cultivated crop as well as the procedures for plant introduction and phenology plots for evaluation of jojoba adaptability to new environments is discussed. Experiences of researchers working with the variable character of jojoba are summarized.

Methodology of selection and evaluation procedures as well as comparative seed yield of the material selected, available in the literature, are presented. The importance of seed yield as the main selection criterion and evaluation of clones at different localities to measure their environmental stability are suggested.

The variable character of jojoba is discussed in terms of yield components and botanical traits that should be considered in hybridization programs. The importance of selection of plants tolerant to environmental stress and harvestability is outlined.

Male selection deserves special attention because it may be the way to improve seed quality and increase yield potential of selected female cones.

6

Genetics for Improved Jojoba Production

Hal C. Purcell, M.D. Purcell Jojoba Company, Avila Beach, CA 93424, USA

Genetics is the key to cost-effective jojoba production Planting selected genetic plant material already has significantly increased yield in commercial jojoba fields in the U.S. Even greater improvements will occur as more productive cultivars are identified and released.

Selection and cloning of high-performing plants with apparently favorable heterotic gene combinations are used to capture and fix the hybrid vigor resulting from millions of years of jojoba's natural outbreeding in the wild. Perhaps in the long term, biotechnology and jojoba plant breeding programs may further improve production.

An extensive jojoba plant selection and testing program evolved from a Cooperative Research Agreement between the University of California and Purcell Jojoba Company. Over the past six years, the highly heterogenous seed-planted fields in the U.S. have provided a vast variety of genetic plant material for this program. Over 1,000 genotypes have been selected, cloned and planted in our 55 acres of randomized and replicated variety field trials. These potential cultivars are analyzed and evaluated for elimination or for further testing and commercial multiplication.

This progress report describes our genetic improvement program and how it is continuously integrated with current cultural practices and with commercial jojoba planting requirements.

7

Propogation of Jojoba by Stem Cuttings

David A. Palzkill, Plant Sciences Department, University of Arizona, Tucson, AZ 85721, USA

For timely development of commercially acceptable cultivars of plant species like jojoba, asexual methods of propagation are necessary. Long generation times and a high degree of natural variability prevent rapid development of acceptable seed-propagated cultivars. Propagation of jojoba by stem cuttings is one asexual method that has been studied by several researchers and has made its way into commercial use.

A wide variety of techniques has been used successfully to root jojoba cuttings. In general, semi-hardwood cuttings with some green still present at the point of detachment are collected, treated with one of a variety of auxins, stuck in a well-drained, sterile medium, and then maintained under intermittent mist or fog until rooting occurs, usually within six to eight weeks. Uprooted cuttings can be stored under refrigerated conditions for up to two months with no decrease in rootability. Use of bottom heat is beneficial, especially during cooler periods.

Among factors known to influence rooting and subsequent growth are genotype, position along a branch from which the cutting is taken, time of year, auxin treatment, and fertilization during rooting. Each of these will be discussed.

8

Application of Plant Biotechnology for Clonal Propagation and Yield Enhancement in Jojoba

Chi Won Lee, Department of Horticulture, Colorado State University, Fort Collins, CO 80523, USA

As in many other economically important crops, potential benefits of plant technology may be realized in jojoba. The use of plant tissue culture is one of those areas that has been successful in vegetative propagation of jojoba. In vitro culture of apical and axillary meristems has resulted in the establishment of large-scale plantations, especially when superior clones are needed. Another area of biotechnology that has been applied to jojoba is the introduction of asexual embryos. This offers the possibility of jojoba oil production from test tubes. However, this method of oil production does not appear to be feasible economically. Recombinant DNA technology has not been applied to jojoba, mainly due to difficulty in regenerations plants from protoplasts. As research progresses, delivery systems for engineering desirable genetic traits such as cold tolerance may be possible. Advances and future potentials of plant biotechnology in jojoba propagation and genetic improvement will be discussed.

9

Soil and Plant Analysis for Maximizing Growth, Production & Freeze Resistance of Jojoba

Albin D. Lengyel, Lengyel's Agricultural Consulting Service and Laboratory, Phoenix, AZ, USA

Commercially grown jojoba, *Simmondsia chinensis*, is susceptible to most mineral deficiencies and readily exhibits these mineral deficiencies. Growth of the plants as well as seed production and susceptibility to freezing can be regulated by a combination of both soil and plant analysis. Standards for minerals which regulate the jojoba plant have been established for both soil and plant materials.

10

Nutritional Requirements of Jojoba

Wesley M. Jarrell, Director, Dry Lands Research Institute, University of California, Riverside, CA 92521, USA

The mineral nutrient requirements of jojoba, a woody evergreen perennial, are best established by correlating plant foliar concentrations with the yield of oil for the plant to establish a physiological relationship. Before coming into production, vegetative growth may provide an indicator of adequacy of nutrient supply. Earlier research and observation have been conducted primarily with seedlings, which may be highly variable in growth and possibly physiological requirements. Now that clonal materials are available the opportunity to obtain reproducible tissue concentration standards has increased greatly. Time of sampling, leaf age and leaf location, and, to some extent, method of sample preparation are critical parameters to evaluate for jojoba, as others have for crops such as citrus. Then the question becomes how one can best supply the nutrient to the plant. In particular, what are the best fertilizer forms; what is the optimum application technique in terms of placement; what is the critical time of year in which jojoba accumulates nutrients from the soil; and during what time of year should tissue concentrations be optimum for high oil production? These questions need to be examined systematically, both under controlled conditions and in the field, to make the best use of available resources in jojoba production.

11

Ground Harvesting of Jojoba

Wayne Coates and **Bruce Lorenzen**, University of Arizona, Tucson, AZ, USA.

Until recently, ground harvesting of jojoba was considered to be unsuitable and impractical. Consequently, most development programs have been directed toward over-the-row harvesters that are designed to knock the seeds from the plants and then catch them before they fall on the soil surface.

In principle, this harvesting theory seemed appropriate, but the non-uniform maturity of the seeds, combined with adverse weather conditions and slow field speeds of the equipment, resulted in excessive harvesting losses. These high losses, combined with relatively expensive harvesting equipment that has practical limitations for straddling mature plants, prompted commercial operators and researchers to investigate alternative harvesting methods.

Ground harvesting is one such alternative. If the seeds are allowed to mature naturally and fall to the soil surface, the entire crop can be harvested in one pass. This reduces equipment operating costs and negates the possibility of weather losses brought about by shattering. For ground harvesting to be effective, however, two additional field operations must be carried out before harvest. The plants must be trimmed to permit the harvesting heads to pass under them, and the soil surface must be prepared both to minimize the amount of soil and rock picked up, and to provide a relatively smooth surface from which the seeds are collected.

12

Economics of Ground Harvesting of Jojoba

E.J. Carnegie, California Polytechnic State University, San Luis Obispo, CA, USA

The operating cost of a ground pickup system for jojoba was investigated. The machine used in this study was a JojobaVac manufactured by Arid-Oil Inc. in Sanger, California. The jojoba fields are owned by Purcell Jojoba Co., located in McVay, Arizona. To determine the economical feasibility of ground harvesting, the field operations of ground preparation, sweeping and pickup were studied. In addition to the field costs, harvesting efficiency was determined by hand-cleaning eight different locations in a 90-acre field after the last pass was made by the JojobaVac harvester. It was determined that approximately 84% of all the seed in the field was removed.

13

Optimum Production of Jojoba Based on Agronomic Factors

Kenneth L. Ludeke, Southwest Desert Farms Inc., Phoenix, AZ, USA

When attempting to evaluate various cultural practices and their relationships to various plant growth characteristics, it readily becomes apparent that the task is demanding. The reasons are (a) lack of complete knowledge of the crop, (b) absence of established referral data based on clear observations and (c) shortage of adequate testing systems. The testing system in jojoba should be based on well-documented physiological responses that affect specific yield components.

External parameters that affect yields during the development of the jojoba plant include the following: soil texture, nutrient level, water quantity and quality, insect resistance, photoperiod, irradiance, temperature, plant density, morphology and cultivars. Obviously, only some of these are controllable under practical farming conditions, and not all of these affect yield in the same manner. If we are to attempt to manipulate yield, we should understand that interactions between those factors and gain insight to the rate-limiting steps during plant development. Once the processes are defined, several scenarios may develop in which alleviation of these limitations will result in higher yields of jojoba. Furthermore, a specific test system then may be designed to evaluate cultural practices having the desired effect, and substantiation of the working hypotheses can be achieved from full-scale experimentation in the field.

The process of evaluating vegetative growth and its direct effect on yields becomes complicated when dealing with jojoba, primarily because the events that occur during the vegetative process do not necessarily translate to the reproductive phase of growth. Chemical limiting factors for maximum yields are prevalent in jojoba, and a more thorough knowledge of the physiology and chemistry of jojoba may become the key to success. For example, yield depends on the net seasonable photosynthesis of the jojoba canopy, and the relationship remains valid under a range of treatments such as variations in population, shading and fertilizer treatments. Special attention should be given to the quality and uniformity of light, temperature, humidity and other environmental factors for the successful documentation and implementation of jojoba research for yield enhancement.

14

Processing of Jojoba

David C. Tandy, EMI Corporation, Des Plaines, IL 60018, USA

To reach the goal of converting the growing of jojoba from a wild desert bush to a fully cultivated crop capable of producing a sufficient quantity of seed each year to service the markets, the research on breeding, growing and harvesting continues to make important discoveries. The final step in producing a jojoba oil suitable for use in the various applications to be discussed later in this conference is in separation of oil from the seed.

The technology of processing oilseeds such as jojoba to produce a high quality oil and the by-product meal is well developed, having been in commercial operation on other oilseeds for more than 80 years. It is necessary only to adapt this technology for use with the jojoba seed.

This paper will present details for the basic steps in oilseed extraction as it applies to the jojoba seed. Although the harvesting procedure probably will include separating trash and debris from the seeds, some will remain with the seed when it arrives at the processing plant. Thus, the furst necessary step is to clean the seed thoroughly using a combination of screening and air aspiration equipment. The preparation step may include drying and dehulling, hull separation and disposal and, finally, conditioning (heating and moisture adjustment) to provide the optimum conditions for extraction. Mechanical extraction using a screw press then follows. For maximum recovery of jojoba oil, the presscake from mechanical extraction then can be extracted further with hexane solvent. Each step must be designed to provide for maximum recovery without damaging the oil quality. The oil recovered in both extraction stages then can be processed further to remove impurities or color and to produce a wide variety of products.

15

Semicontinuous Supercritical CO_2 System for Rapid Extraction of Jojoba and Other Oilseeds

John P. Friedrich, Northern Regional Research Center, USDA/ARS, 1815 N. University Street, Peoria, IL 61604, USA

Cold pressuring and expelling are the current methods for the separation of jojoba oil from the seed. These methods leave appreciable quantities of residual lipid in the residue. Removal of the residual oil can be accomplished by traditional petroleum extraction, but also supercritical carbon dioxide (SC-CO_2) can be employed successfully as an alternative solvent for both crushed full-fat seed and presscake. However, rapid extraction by this method has been hampered by slow percolation of SC-CO_2 through high oil substrates, resulting in rapid packing and complete loss of flow. We have now designed a pilot-size semicontinuous three-vessel system with improved flow characteristics and high throughput.

16

Methods of Analysis for Jojoba Oil

Gayland F. Spencer, Northern Regional Research Center, USDA/ARS, 1815 N. University Street, Peoria, IL 61604, USA

An overview of methods that have been used in the analysis of wax esters will be discussed with a particular emphasis on quantitative determination. Gas, thin layer and high performance liquid chromatographic techniques that have been applied to wax esters from jojoba and from other sources will be presented. Inclusion of wax esters other than those from jojoba will be used to demonstrate ways in which these techniques can been applied to jojoba analysis. Means of derivative preparation for wax esters also will be reviewed together with a mass spectrometric analytical scheme that can be used to determine the alkoxy-acyl combinations within each wax ester chain length. Development of methods for the analysis of jojoba oil in formulations such as cosmetics will be described.

17

Comparison of Properties and Function of Jojoba Oil and Its Substitutes

Marvin O. Bagby, Northern Regional Research Center, USDA/ARS, 1815 N. University St., Peoria, IL 61604, USA

In 1935, chemists at the University of Arizona found that jojoba seed oil was unique, consisting of wax esters instead of typical triglycerides. The esterified acids and alcohols are mostly $C_{20:1}$ and $C_{22:1}$. These wax esters are similar to those of sperm whale oil and satisfy many of the cosmetic markets previously supplied by sperm whale oil. Other suggested potential markets include lubricants, pharmaceuticals and other industrial products. Bench scale and simulated in-use tests generally show that jojoba oil performs as well as or better than sperm whale oil or similar wax esters synthesized from natural triglyceride fatty acids such as erucic acid or limnanthes fatty acids. Physical properties of these products will be discussed and compared with those of wax esters available from orange roughy fish or derived by fermentation.

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Economics of Jojoba: The Cases of Southwest United States and Israel

Dan Dvoskin, HESHEV, Tel Aviv, Israel

Jojoba, considered by many to be a new crop, now is grown commercially in many countries of the world. While much uncertainty still remains in the production and marketing, the jojoba industries in both the U.S. and Israel have developed quickly using mostly private funding and relatively little government support. Further development and commercialization of jojoba in those countries greatly depends on the future expected economic performance of the crop.

This study presents an economic evaluation of jojoba production based on current and expected changes in the growing conditions in the Southwest U.S. and in Israel. The study employs an economic model which examines the economic performance of continuous jojoba production over 25 years under changing yields and prices.

Assuming increased oil yields as a result of improved plant selection, the study finds that jojoba can become a viable economic crop in the Southwest U.S. The study also shows that the more favorable growing conditions (frost-free and mild climate) in Israel already have resulted in much larger production potential than that of the U.S. However, the climatic advantages of Israel are offset economically by production costs that are much greater than those in the U.S.

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Supply, Demand and Price Characteristics of Jojoba

William C. Watson, Desert King Corporation, Chula Vista, CA 92011

The successful commercialization of jojoba as an economically viable crop is dependent largely upon the development of volume markets matched to the output of the plantations at prices that can support current growers and stimulate new technological advances in jojoba cultivation.

As with virtually any commodity, price and demand for jojoba are dictated solely by the marketplace with no consideration given to the needs of the plantations. Given jojoba's relatively high price, downward pricing pressure will continue, particularly as volumes increase. Thus, the impetus is on the growers to produce jojoba as economically as possible.

Long-term pricing and supplies will be a function of market demand and simple agricultural economics and will be related directly to a plantation's income-producing potential relative to other perennial cash-producing crops that may be planted in its stead. Higher-than-typical income realization will result in increased jojoba plantation development, while lower-income realization will result in a slowing of plantation development. However, certain characteristics unique to jojoba may result in a somewhat more favorable profit outlook than can be projected with other crops.

Unlike other vegetable oils, jojoba cannot be replaced readily with other functionally equivalent oils in many formulations. This should result in a lesser degree of price and demand elasticity. Additionally, jojoba can be cultivated on land that may be less suitable for other crops, reducing the potential for direct competition for land utilization. Finally, the risks involved with jojoba cultivation are greater than those of other crops largely due to frost sensitivity, harvesting difficulties and non-uniform cultural practices. These concerns should result in a more conservative approach to jojoba cultivation relative to other crops.

Models will be presented, illustrating supply, demand and pricing characteristics of jojoba as the industry evolves. Based upon our current level of market and agronomic knowledge, long-term supply, demand and price projections will be given.

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Recent Advances in the Chemistry and Properties of Jojoba Oil

Jaime Wisniak, Department of Chemical Engineering, Ben-Gurion University of the Negev, Beer-Sheva, Israel

Recent developments in the chemistry, property evaluation and derivatization of jojoba oil will be discussed. The extraction and hold-up characteristics of jojoba meal have been determined for hexane and isopropanol systems. Phase behavior of mixtures of jojoba oil, carbon dioxide and several Freons have been measured, as well as the solubility of the oil in numerous solvents. Pressure-temperature-viscosity curves of jojoba oil, pure and sulfurized, have been described for pressures up to 2000 bar. In-depth analysis of the accelerated oxidation of crude oil, bleached oil and stripped jojoba oils have shown the importance of the natural antioxidants present in the oil.

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Review of Lubricant Properties of Jojoba Oil and its Derivatives

Israel J. Heilweil, Visiting Fellow in Molecular Biology and Chemical Engineering Departments, Princeton University, Princeton, NJ, USA

Early and current literature on the chemical and physical properties of jojoba oil and its derivatives relevant to lubrication additive technology will be reviewed in light of available laboratory, practical and engine-testing results. Research and economic consequences of limited "scoping" evaluation will be discussed, and possible alternative evaluation approaches suggested. Trends and future directions in various fields of lubrication that could influence the development and use of jojoba-based materials also will be presented.

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Potential Use of Sulfurized Jojoba Oil as an Extreme Pressure Additive

V.K. Bhatia, G.A. Sivashankaran, R.P.S. Bisht, Alka Chaudhry (speaker) and **S.K. Chhibber**, Indian Institute of Petroleum Dehra Dun 248005, India

As a part of the studies on the utilization of renewable sources to conserve and eventually to replace hydrocarbons derived from petroleum, one of the investigations undertaken at the Indian Institute of Petroleum relates to the potential use of derivatives of jojoba oil as additives. This paper presents the results on the utilization of sulfurized jojoba oil as an extreme pressure (EP) additive.

Studies include sulfurization of jojoba oil, optimization of reaction conditions, structure-performance relationship, physico-chemical and performance evaluation, and comparative assessment with a commercial additive. Because the results were quite encouraging, an industrial gear oil formulation has been developed using sulfurized jojoba oil as an extreme pressure additive. The results suggest that sulfurized jojoba oil has good potential for use as an EP additive in applications in which sulfurized products derived from petroleum hitherto were used.

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Laboratory Evaluation of Sulfurized Jojoba Oil as a Gas Turbine Lubricant

Kishore Kar, Dow Chemical Company, Midland, MI 48674, USA

This paper describes the extreme pressure and antiwear properties of jojoba oil, sulfurized (0.5–10%) jojoba oil, and that of a polybutene-base commercial gas turbine syn-lube. All these fluids were subjected to a fourball test in the Falex friction and wear tester

simulating the temperature and pressure normally experienced in GE 7001-E gas turbines. Data from these comprehensive tests indicated that both low percent (0.5%) sulfurized jojoba oil and refined jojoba oil alone are superior in performance from a lubrication point of view compared to the commercial synlube. Furthermore, the experimental investigation revealed that excessive sulfur content leads to the formation of deposits around the lubricated (contact) surface. The sludge, if not dispersed properly, interrupts the flow of lubricant to the interfacial areas causing poor (starved) lubrication.

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Novel Derivates of Jojoba Oil and Some Bench Test Friction Reducing Results

Phillip S. Landis, Glassboro State College, Glassboro, NJ, USA

There have been a number of studies of organic reactions with jojoba oil. This is not surprising in view of the unusual structure, the increasing availability and the presence of several reactive groups in the molecule.

$$CH_3(CH_2)_6CH_2CH{=}CHCH_2(CH_2)_mCH_2\underset{\displaystyle O}{C}\text{-}O\text{-}CH_2(CH_2)_nCH_2CH{=}CHCH_2(CH_2)_6CH_3$$

Thus, reactions can be carried out using the double bonds, the carboxyl group, the allylic methylene groups or the methylene group adjacent to the carbonyl and oxygen linkages.

Our recent work has involved (a) the pyrolysis of jojoba under conditions that produce diolefins and carboxylic acids; (b) lithium aluminum hydride reduction to jojoba alcohols and conversion to ethers via the Williamson Ether Synthesis; (c) acid-catalyzed dehydration of jojoba alcohols to yield high molecular weight dienes; and (d) photoinitiated additions to the double bonds. Many of the products have been examined for friction-reducing characteristics in a lubricating oil. Only those products containing oxygen show a reduction in the coefficient of friction, and it appears that free hydroxyl groups are necessary for maximum effect.

Pyrolysis of jojoba oil at 375 C under nitrogen and 250 mm vacuum produces a high yield of a mixture of C18-C14 unsaturated acids and diolefins. In both cases, the C20 and C22 analog make up about 90% of the pyrolysate. The acids readily were separated from the diolefins by liquid chromatography with activated alumina and hexane solvent. Caustic separation was not feasible because of the appreciable solubility of the sodium salts of the C20-C22 acids in organic solvents.

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Synthesis of Methyl and Ethyl Jojobates by Transesterification and Their Use in Jojoba-Based Body Cream Preparation

B.D. Shethia, Meena Gohel, J.B. Pandya and **E.R.R. Iyengar** (speaker), Central Salt & Marine Chemicals Research Institute, Bhavnagar 364002, India

Jojoba oil is a liquid wax containing 97% linear straight chain esters. The acids that are derived from jojoba are a mixture of cis-11-eicosenoic (C20) and cis-13-docosenoic (C22) acids. The derived alcohols are a mixture of cis-11-eicosenol and cis-13-docosenol. Methyl and ethyl jojobate were synthesized successfully by transesterification using methanol or ethanol containing 7–8% of dry hydrogen chloride. The physicochemical properties have been studied and compared. It is observed that the saponification values of jojoba wax ester have been increased significantly by transesterification. The transesterified oil was used in the preparation of stable body cream (W/O emulsion) for the cosmetic industry. The carbon and hydrogen analyses have been compared for the values of m and n in the acids and alcohols in the oil from recently harvested jojoba seeds from the Saurashtra region of Gujarat. The transesterified oil has been used successfully in a body cream formulation.

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Alkoxylated Jojoba Derivatives in Cosmetics

Ronald J. Smith, Technical Director, Heterene Chemical Co. Inc., Paterson, NJ, USA

Methods of preparation of ethoxylated and propoxylated derivatives of jojoba oil are discussed. Effects of varying the degree of alkoxylation on such properties as solubility, substantivize and gel formulation are explored. When used in model skin care and hair care formulations, these derivatives are shown to exhibit unusual solubilization and thickening properties. Ongoing work in quaternization of jojoba alkoxylates to increase substantivize is discussed.

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Skin Surface Softening Effects of Joioba and Its Derivatives

Michael S. Christensen (speaker) and **Elias W. Packman**, Institute for Applied Pharmaceutical Research Ltd., Merion, PA, USA

A discernible and objectively measurable increase in skin surface softness is brought about by emollients and moisturizing products that increase the extensibility of the stratum corneum. Such a change is beneficial in the treatment of dry skin. Jojoba oil, jojobutter and ozonized jojoba oil have been found to bring about substantial and long-lived skin surface softening effects when applied topically, either neat or in simple emulsions. This characteristic provides good evidence for the utility of jojoba products as additives to cosmetic formulations.

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Application of Jojoba Oil to Cosmetic Products

Yoshikazu Hirai and **Takahiro Tanigawa**, Pola Laboratories, Pola Corporation 27-1 Takashimadei, Kanagawa-ku, Yokohama 221, Japan

We use many components in cosmetics to keep skin in the best condition and to keep moisture in the skin.

The components that we mainly use for cosmetics are as follows: (a) oil (such as jojoba, squalane); (b) natural moisturizing factor (such as amino acids, pyrrolidonecarboxylic acid, glycerol); (c) human epidermal lipid (such as phospholipids, sphingolipids); and (d) hyaluronic acid, which holds bound-water tightly.

Recently, phospholipids, sphingolipids and hyaluronic acid have become very important components for cosmetics because in the Japanese market, many consumers have been wishing to get more effective cosmetics that are not sticky and oily.

However, we should take into consideration that oil is another important ingredient for cosmetics, especially for milky lotions and creamy products to smooth the skin.

To be able to create skin-care products and make-up products that can keep the moisture level and smoothness of the skin, we use jojoba oil. The main reason for using jojoba oil in make-up products is because we want them to spread well and improve the smoothness when they are applied to the skin.

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Current Status of Jojoba Oil Utilization of Cosmetics in Japan

Mitsuo Kato (speaker) and **Takeshi Kunimoto**, Koei Perfumery Co. Ltd., 23, 2-Chome, Kanda-Awajicho, Chiyoda-ku, Tokyo 101, Japan

Since 1973, we have been developing jojoba oil and its derivatives as cosmetic ingredients. During that time, we have confirmed the safety of these materials as cosmetic ingredients by carrying out necessary safety examinations in various ways.

Consequently, jojoba oil (refined oil and deodorized oil), hydrogenated jojoba and jojoba alcohol have been employed widely in Japanese cosmetics.

The presentation will include (a) for what kinds of cosmetics jojoba oil has been used; (b) proportion of the use for individual cosmetics; (c) how the change in price of jojoba oil influenced the kind of jojoba-formulated cosmetics.

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The Jojoba Potential: An Overview

James H. Brown, President, Jojoba Growers & Processors Inc., 2267 S. Coconino Dr., Apache Junction, AZ, USA

Since jojoba came to the attention of industry in the mid-1970s there have been numerous projections of its predicted utility and subsequent utilization.

The author will review those projections in view of the present status of the jojoba industry with specific analysis of the cosmetic potential with derivatives of jojoba.

A history of jojoba oil consumption and oil and seed prices since 1975 will be presented as a consensus of the four active jojoba oil processors in the U.S.

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Animal and Human Acceptability and Tolerance of Jojoba Oil as a Dietary Fat

Krishna Anantharaman, Nestec Research Department, Lausanne, Switzerland

Diets of people in the developed nations usually are too rich in animal fats and vegetable oils, which provide more than 40% of the daily energy intake. Triacylglycerols contribute to energy storage by virtue of their high energy yield. A large body of scientific evidence suggests that high-fat, high-cholesterol-containing diets are conducive to the development of coronary heart disease and related disorders.

Nutritionists and food scientists have intensified their search for alternatives that are either fat substitutes or that may be used as partial fat replacers because of their low digestibility in vivo. Interest in reducing fat energy intake, not by exclusion of fat from the diet but by significantly reducing or preventing its absorption, has stimulated research on transesterified conventional fats and on the liquid waxes of jojoba (*Simmondsia chinensis*), which possess desirable physical and culinary properties besides being resistant to oxidation.

Jojoba waxes, liquid at about 10 C, are a mixture of linear esters of monounsaturated, long chain fatty acids and long chain primary fatty alcohols, suggesting poor absorption despite a higher gross energy (10.3 kcal/g) value than conventional oils and fats (9.3 kcal/g). Jojoba oil is not hydrolyzed in vitro by pancreatic lipase. It only partially (about 40%) is digested when incorporated into animal diets at meaningful levels.

A variety of animal studies in recent years have investigated its metabolism, pharmacokinetics, effects on liver and heart mitochondrial membranes and their integrity, subacute and subchronic toxicity, influence on fat-soluble vitamins, hematological status, clinical chemical parameters, etc. Such investigations reinforce both the concern of researchers and the importance of extensive safety evaluation of jojoba oil when the intent is for dietary use. In short-term tests in informed, obese volunteer subjects in a weight reduction program under medical supervision, jojoba oil has found high acceptability and tolerance over a three-to-six week period of study. Although jojoba oil intake led to significant reduction in blood cholesterol in these subjects, changes in certain chemical parameters also were recorded. These, however, were somewhat similar to those reported in subjects on either fish or fish oil regimens. This paper will attempt a critical overview of the various animal and human studies by various research groups and will evaluate the potential of jojoba oil as a "low-metabolizable" dietary fat.

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Regulatory Requirements for Food Use of Jojoba Oil

Douglas L. Park, Department of Nutrition and Food Science, University of Arizona, Tucson, AZ 85721, and **Karen L. Carson**, Department of Food Chemistry and Technology, Food and Drug Administration, Washington, DC 20204, USA

Jojoba oil's unique characteristics raise attractive possibilities for its use in foods designed to reduce dietary fat and/or caloric levels. These same characteristics, however, apparently raise questions about its safety that must be resolved before a user approaches the Food and Drug Administration (FDA) to obtain clearance for its use. FDA has a regulatory structure in place to categorize new food ingredients as either GRAS substances or food additives; both hinge on the "safety" of the substance. A food additive is considered safe if there is a reasonable certainty that it is not harmful under the intended conditions of use. FDA's criteria for assessment of safety involve consideration of several types of information, including toxicological data and human exposure assessment.

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Developments on Use of Jojoba Meal as Animal Feed

Charles G. Manos, Environmental Science and Engineering, Inc., Gainesville, FL, USA

Jojoba (*Simmondsia chinensis*) meal was incorporated as 5% and 10% of the ration and fed to wether and ewe lambs. Residues of simmondsin and simmondsin 2′-ferulate as determined by high-pressure liquid chromatography were not detected in kidney, liver, muscle or blood of sheep fed jojoba meal. No direct-acting mutagens or promutagens were found in the jojoba meal or rations containing it. Liver protein and aminopyrene N-demethylase activity significantly were lower in the rams fed the 10% jojoba meal ration than in the corresponding controls. Organ function tests showed a significantly decreased BUN and a significantly increased GGTP in the ewes fed jojoba rations compared with the respective controls. No changes in tissue ultrastructure were served when examined by electron microscopy for any of the dietary treatment groups. Ensiling jojoba meal with green chopped corn appears to improve its palatability for lambs.

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Protein and Digestive Enzyme Reactions with Jojoba Tannins

Manual Sanchez-Lucero, University of Sonora, Hermosillo, Sonora, Mexico

Albumins, globulins and glutelins constitute approximately 90% of the jojoba protein. Tannins constitute approximately 7% of the jojoba testa, and the testa is 8% of the jojoba bean. Jojoba albumins constitute 40% of the jojoba protein and four fractions by gel filtration on Sephadex G-100. Two of these fractions react with jojoba tannins, forming soluble protein-tannin complexes; foam stability time is increased by 50%. Two of the four fractions of jojoba globulins react with jojoba tannins, and a precipitate is formed, leaving only two fractions for enzymatic digestion. Trypsin totally is inhibited by jojoba tannins at 3.2 g/ml tannins and 1:28 tannins/enzyme ratio. That inhibitory effect was related directly to the tannins concentration. Chymotrypsin was inhibited at higher concentration than trypsin was, but the relative inhibition coefficients were similar.

Contributed Poster Presentations

P1

CF Systems' Process for the Extraction of Jojoba Seeds with Condensed Gases as Solvents

Paul N. Rice and **Ramin Abrishamian**, CF Systems Corp., Cambridge, MA, USA

P2

Post-Harvest Handling of Jojoba Seed

Timothy C. Timmons, Dan Pitterle and **Carole A. Whittaker**, Hyder Jojoba Inc., Phoenix, AZ, USA

P3

Sampling and Moisture Analysis of Jojoba Seed Following Harvest

Carole A. Whittaker, Dan Pitterle and **Kurt Kroner**, Hyder Jojoba Inc., Phoenix, AZ, USA

P4

Jojoba Around the World

Johanns von Franz, Ciumbuleuit, Bandung, Indonesia

P5

Auxin Effects on Jojoba

S.K. Ballal, Tennessee Technological University, Cookville, TN, USA

P6

Production of Jojoba on Coastal Sand Dunes of India

E.R.R. Iyengar et al., Central Salt & Marine Chemicals Research Institute, Bhavnagar, India

P7

Jojoba Germplasm Evaluation and Genetic Improvement

Himayat H. Naqvi, University of California, Riverside, CA, USA

P8

Ecologia Vegetal de la Jojoba en Zonas Semiarides y Sub-Humedas del Paraguay

Julio Spinzi, Comisión Nacional de Desarrollo del Chaco, Paraguay

P9

Evaluation of the Phenotypical Variation in Jojoba Based on the Production at Different Ages

R. Ayerza and **D. Zeaser**, Asociacion Latino-Americana de Jojoba, Buenos Aires, Argentina

P10

Jojoba Waxes: In Vitro Lipolysis and Two-Month Rat Feeding Studies

A. Bizzi and **M.Cini**, Instituto di Ricerche Farmacologiche, Milan, Italy; and **U. Bracco**, Nestlé Research Center, Lausanne, Switzerland

P11

Biological Effects of Feeding Jojoba Oil and Synthetic Wax Esters to Rats

R. Stalder, M. Marchesini, A. Bexter and **D. Decarli**, Nestlé Research Center, Lausanne, Switzerland

P12

Jojoba Waxes: Studies in Obese Human Subjects

G. Debry, R. Rohr, R. Stalder, K. Anantharaman and **U. Bracco**; Universite de Nancy, Nancy, France; Mutelle Generale de l'Education Nationale, Colmar, France, and Nestlé Research Center, Lausanne, Switzerland

P13

Wind Analysis for Pollination of Jojoba

Ron Kadish, Ag Associates, Camarillo, CA, USA

P14

Effects of Bioregulators on Out-of-Season Flowering

Ron Kadish, Ag Associates, Camarillo, CA, USA

P15

Measurement of Solid/Liquid Ratio of Individual Jojoba Seeds by Low Resolution Pulse NMR

Phan Phuc Anh, Universite Pierre et Marie Curie, Paris, France

P16

Jojoba Growing in Pakistan

M.H. Panhwar, Research and Development Engineers, Karachi, Pakistan

P17

Screening Jojoba Seed for High Wax Content

Ron Kadish, Ag Associates, Camarillo, CA, USA

P18

C12/C14-Fatty Alcohols from Jojoba Olefin Metathesis

S. Warwell, A. Deckers and **N. Doring**, Rheinisch-Westfalischen Pechmischen Hochschule, Aarchen, West Germany

P19

The Variation in Liquid Wax Content of Jojoba (*Simmondsia chinensis* [Link] Schneider) Seed from the Sonoran Desert

R. Ayerza and **V.C. Chamupathi**, University of Arizona, Tucson, AZ, USA, and Desert Whale Jojoba Co. Inc., Tucson, AZ, USA

P20

Elimination of Toxic Compounds, Nutritional Evaluation and Partial Characterization of Protein from Jojoba Meal

L.A. Medina, A. Trejo and M. Sánchez, University of Sonora, Hermosillo, Sonora, Mexico

P21

Protein Extractability of Defatted Jojoba Meals: Effects of Ph and Salt Concentration

Walter J. Wolf, Mardell L. Schaer and Thomas P. Abbot, USDA, Northern Regional Research Center, Peoria, IL, USA

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Monitoring Jojoba Toxins by Fourier Transform Infrared Spectroscopy and HPLC

T.P. Abbot, R.E. Peterson, L.K. Nakamura, T.C. Nelson and M.O. Bagby, USDA, Northern Regional Research Center, Peoria, IL, USA

Meetings

1988 meeting to feature 300 talks

Approximately 300 technical presentations are scheduled for the 1988 annual meeting of the American Oil Chemists' Society, to be held May 8-11, 1988, at the Phoenix Civic Plaza, Phoenix, Arizona.

The meeting registration desk in the Exhibit Hall (Hall E) at the Phoenix Civic Plaza will be open from 2 to 6:30 p.m. Sunday, May 8. The first social event is the Sunday evening opening mixer, which will be held in the registration/exhibit area from 6:30 to 8:30 p.m. There, participants will be able to renew acquaintances, meet new people and enjoy hors d'oeuvres and drinks.

The technical program will run from Monday morning, May 9, through late Wedneday afternoon, May 11. The annual awards breakfast is scheduled for 7:30 a.m. Monday in the Ballroom at the Phoenix Civic Plaza, with plenary sessions beginning at 9 a.m. The tentative technical program is published in this issue of *JAOCS*. The final program will be included in the meeting portfolios given to attendees at the registration desk.

In addition to Sunday afternoon hours, the registration desk will be open from 7 a.m. to 5 p.m. Monday and from 8 a.m. to 5 p.m. Tuesday and Wednesday. The accompanying exhibit is scheduled to be open Sunday, May 8, from 2-8:30 p.m.; Monday and Tuesday, May 9-10, from 9 a.m. to 5 p.m., and on Wednesday, May 11, from 9 a.m. to 1:30 p.m.

Topics featured at the meeting will include the pharmacological effects of lipids—the role of lipids in carcinogenesis and therapy, a protein and co-products symposium, flavor chemistry of food lipids, new frontiers of plant lipid research, soaps and detergents, physical chemistry of fats and oils, frying fats and oils for the fast food industry, fats and oils processing, jojoba oil, dietary aspects of fats and oils with emphasis on omega-3 fatty acids, HPLC analysis of lipids and proteins, corrosion in processing equipment, disposal of bleaching clays, castor oil and meal, and capillary column chromatography.

A special feature at this year's meeting will be a session focusing on the outlook for oilseeds, fats and oils. Invited speakers are Thomas Mielke of *Oil World*, Joseph Smith of Oilseeds International, Philip Mackie of the U.S. Department of Agriculture's Foreign Agricultural Service and Mario Balletto, Merrill Lynch's oilseeds analyst in New York. The outlook session is scheduled for Monday, May 9.

Awards to be presented at the Monday breakfast will include the Supelco AOCS Research Award, AOCS Award of Merit, The Soap and Detergent Association Award for best technical paper on surfactants and detergents published in *JAOCS* during 1987; the Archer Daniels Midland Awards for best technical papers relating to protein and co-products; and the Ralph H. Potts Memorial Fellowship. Also recognized will be the AOCS Honored Students and the top-ranking Smalley Check Sample Program participants.

There also will be an inaugural lunch, slated for Wednesday, May 11, at noon in the Ballroom. The incoming president will speak, and other new officers will be installed.

General chairman for the 1988 meeting is Arnold Gavin. Neil Widlak of Kraft Inc. serves as technical chairman. Other members of the local committee include the following: David C. Tandy of EMI Corp., registration; Frank Hutcheson of EMI, technical session arrangements; Mary McPherson, entertainment; John Woerfel, exhibits; Jay Patel of The Dial Corp., golf; Joan D. Gavin, spouses' program, and James H. Brown of Jojoba Growers & Processors, plant trip.

Registration and housing reservation forms are included in this issue of *JAOCS*. Additional copies may be obtained from Joan Dixon, Meetings Manager, AOCS, PO Box 3489, Champaign, IL 61821-0489. Registrants should send completed