Symposium 6 (S06): The Future for Medicinal and Aromatic Plants

Monday · August 12

Location: Metro Toronto Convention Centre, Room 104A

1100–1140
S06–O–1
PLANT MEDICINES, FROM SHAMANS TO STORE SHELVES

Chris Kilham*

Medicine Hunter, Inc., 15 Trapelo Road, Lincoln, MA 01773, USA

The globalization of information and increased awareness of plant resources of all kinds has spurred tremendous demand for a wide variety of plant materials. From specialty coffees to aromatherapy oils to medicinal plant remedies from faraway places, the world market shows a voracious appetite for plants. Indeed, the medicinal plant market is one of the most dynamic and rapidly growing sectors in the field of botanical resources. As people re-connect with natural health-based principles and shy away from expensive and potentially hazardous synthetic drugs, natural medicinal plants offer relief for a wide range of health needs. Today, 85% of the world's population, approximately 5.1 billion people, turn to plants as primary medicines. This tremendous demand for medicinal plants and their preparations opens rich opportunities for individuals, communities, and commercial entities along the chain of medicinal plant trade. Ironically, the economic demand for medicinal and aromatic plants may help preserve natural environments and indigenous cultures in situations in which value-based education efforts have failed. In a world that places more value on an individual's economic worth instead of intrinsic natural or humane merit, a scenario develops in which a hectare of aromatic or medicinal plants may yield more profit than can be derived from timber production, cattle grazing or mining. Equally, in this scenario, indigenous native people can participate and benefit from the cultivation, harvesting, and processing of botanical resources. From cultivation to harvesting, processing, and marketing, we have the chance to simultaneously provide safe, beneficial remedies for human needs and to preserve and promote environmental sustainability and indigenous native cultures. From shamans to store shelves, we'll examine how natural, plant-based medicines transition from the natural environment to the consumer marketplace, and how in the process we can promote values and ideals which remain unfulfilled by other means.

1140–1200
S06–O–2
UTILISATION OF ETHNOBOTANICAL RESOURCES AND SAVING THE DECLINING BIODIVERSITY IN TROPICAL WET EVERGREEN FORESTS OF INDIA

Salil Kumar Ckatterjee*

j/1-7 Labony Estate, Salt Late, Calfutta–700064, India

Ethnobotanical resources used by nearly 600 tribal communities of India present a significant area of biodiversity; the decline of which needs to be sustained. Distinct utilization patterns of these botanical resources and their succession data could demonstrate a steady decline in composition of biodiversity in the tropical wet evergreen forest ecosystem, the operational mode of which will be discussed. Conservational studies centered around four distinct areas: 1) Conservation methods followed by tribals 2) Conservation in isolation of single or mixed target species aided by specific agrarian system 3) Conservation "in situ" under partly denuded forest ecosystem and 4) "De novo" conservation "ex situ". The study showed that tribals used some distinct methods of conservation mainly in their harvesting techniques which could be well substantiated by the biochemical findings of the investigation. The study also revealed that while target species like endangered Rauvolfia, Gloriosa could be best conserved by monoculture system under umbrella species Emblica, Melia; monoculture of Withania, Cassia, Aloe could be successfully conserved by agrarian culture without umbrella species in association. Target species like Catharanthus and Costus survived well in mixed culture. However species like Bacopa, Andrographis flourished only under natural ecosystem 'in situ'. Economics of controlled cultivation of all these species indicated good possibilities of commercial exploitation. Aclimation and conservational trials involving 62 ethnobotanical species in "in situ" and "ex situ" conditions revealed some characteristic features of their survival; details of which will be discussed.

1200–1220
S06–O–3
TRADE, USE AND CONSERVATION OF MEDICINAL AND AROMATIC PLANTS IN LITHUANIA

Jolta Radusiene

Institute of Botany, Zaliuju ezeru 49, LT-2021, Vilnius, Lithuania

The trade of MAP in Lithuania is largely based on wild-collection and import. The average annual volume of plant material coming from the wild comprised about 29%, import–65% of all material used in pharmaceutical industry. Imports came from more than 30 countries. The exports make up a small part of the trade and are mainly directed to the countries of the former Soviet Union. About 150 indigenous species are used in herbal preparations in Lithuania. The five more frequently used native species in phytomedicine are: *Crategus* sp., *Arctostaphyllos uva-ursi*, *Menyanthes trifoliata*, *Hypericum perforatum, Thymus serpyllum*. The trade in wild plant species and their resources is regulated by the following legislation: Law on Protected Areas, Law on Endangered Wildlife and Law on Wild Vegetation. The Ministry of Environment revises the list of species, collection of which is prohibited and regulates the gathering of wild MAP on the basis of research made by specialists. Active conservation of MAP is conducted in accordance with the National PGR program. In line with the increasing demand for MAP material as well as political and economic changes in agriculture, the cultivation of medicinal plants becomes one of the most attractive activities. The main objects of the more intensive cultivation are: caraway, valerian, calendula, chamomile, and peppermint. Cultivation is mainly based on Russian and Polish cultivars. The cultivated production covers the demand for MAP by only 4% to 6%.

1220–1240
S06–O–4
NEW CROPS WITH POTENTIAL TO PRODUCE ESSENTIAL OIL WITH HIGH LINALOL CONTENT HELPING PRESERVE THE TRADITIONAL ROSEWOOD TREES–A SPECIES IN DANGER

Nilson Borlina Maia*, Odair Alves Bovi, Maria Beatriz Perecin, Marcia Ortiz Mayo Marques, Newton do Prado Granja

Av. Barao de Itapura, 1481 Caixa Postal 28 Campinas SP 13001-970 Brazil

Rosewood (*Aniba rosaeodora*) is a worldwide famous tree of the Lauraceae family, growing wild in the Amazon rainforest. An essential oil rich in linalol (up to 86% w/w) is extracted from its trunk and traded to the perfumery market. Nowadays, its essential oil is mainly used in the most expensive and fine perfumes, but since early times the wood was used in carpentry. After 1920, the essential oil exploration began in a predatory way. The whole trunk is transformed in chips and steam distilled. As the essential oil price is very attractive, trees of any age or diameter are logged, which compromises its natural propagation. Due to this reason, the species is in danger, despite many restrictive regulations aiming at its conservation. According to specialized literature, linalol is found in the essential oils of *Coriandrum sativum* L, *Bursera delpechiana*, *Citrus* spp, *Citrus aurantium* subsp. *amara* L, *Laurus nobilis* L, *Cinnmamomun camphora*, *Cinnamomun verum* L, *Matricaria chamomilla* L, *Salvia sclarea* L., *Lavandula officinalis* Chaix and *Ocimum basilicum*. In this paper, the essential oil of those plants were distilled and analyzed looking for linalol content. *C. camphora* and *Laurus nobilis* produced essential oil with 56% and 43% respectively and *O. basilicum* 30%, but the last one has more potential due it propagation and easy cultivation. Despite the different chromatographic profile of rosewood essential oil compared to the species above, they have agronomic advantages that make them a potential alternative source for the rosewood oil in some circunstances.

1340–1440
S06–P–5
BIOAUTOGRAPHIC DETECTION OF ANTIBACTERIAL ACTIVITY OF SOME IRANIAN PLANTS

Javad Behravan*, Mohammd Ramezani, Shirin Ebadi

School of Pharmacy, P.O. Box 91775-1365, Mashhad, Iran, Mashhad, Khorasan, Iran 91775

We used a bioautographic method to investigate the antibacterial effects of essential oils of *Thymus vulgaris, Zataria multiflora, Carum copticum* and extract

of *Ziziphora clinopodioides*. Antibacterial activity of essential oils and extracts were determined against *Basillus subtilis* as a representative gram-positive bacteria and *Escherishia coli* as a representative of gram-negative bacteria. A mixture of molten nutrient agar, INT solution 5 mg·mL^{-1} (as indicator of antibacterial activity) and a bacterial suspension (1_108 cfu·mL^{-1}) in the ratio of 1, 0.5 and 0.01 was poured over the TLC plate which already had been subjected to the sample, dried and incubated at 37 °C for 24 hours. The essential oils of all plants, *Thymus vulgaris*, *Zataria multiflora* and *Carum copticum* showed antibacterial activity against *B. subtilis* and *E. coli* at Rf » 0.4 which represents the Rf for thymol and carvacrol in petroleum ether-chloroform (50-50). No antibacterial activity was observed for the extract of *Z. clinopodioides*. It was shown that the effects was due to presence of thymol and carvacrol in the essential oils.

1340–1440
S06–P–6
SOUR CHERRY (*PRUNUS CERASUS* L.) PRODUCTION TOWARDS THE UTILIZATION FOR A NEW CENTURY

Federica Blando*[1], Rosa Gala[1], Carmela Gerardi[1], Philippe Druart[2]

[1]Istituto di Ricerca sulle Biotecnologie Agroalimentari, CN

Via Prov.le Lecce-Monteroni 73100 Lecce, Italy; [2]CRA–Dept. Biotechnology Chaussée de Charleroi, 234 5030-Gembloux (Belgium)

Bioflavonoids are now recognised as chemoterapeutics for numerous diseases due to their antioxidant activity (Bomser et al., 1996). This group of phytochemicals, and particularly anthocyanins, are valued today as neutraceuticals, that is "food with health benefits". The finding that tart cherries (*Prunus cerasus* L.) contain a great amount of anthocyanin has attracted much attention to this species. Anthocyanins from sour cherry have been demonstrated to possess strong antioxidant and anti-inflammatory activities. Moreover, cyanidin, the anthocyanin aglycon, showed more efficient anti-inflammatory activity than aspirin (Wang et al., 1999). The extraction of anthocyanins from cherry fruits is restricted to their seasonal production, whereas anthocyanins can also be extracted and purified from cherry cell cultures, which are continuous source of plant metabolites. To this purpose, an in vitro cellular system for anthocyanin production has been set up. In vitro leaves from several sour cherry cultivar were put on Callus Induction Medium, and the resulting calli were subcultured monthly on the same medium, growing actively in darkness. Elicitation with light (cool white) and nutritional factors (nitrogen and sucrose) was used for the anthocyanin induction. Changes particularly in the ratio of NH^{4+} and NO^{3-} strongly influenced anthocyanin synthesis. On the other hand, anthocyanin biosynthesis modulation by sucrose did not act in our system, as previously reported in cell suspension cultures of *Vitis vinifera* L. (Decendit and Mérillon, 1996). The time course of anthocyanin production revealed that the pigment appeared 4-5 d after transfer to the light on the Production Medium, and reached a maximum 9 d after transfer, even though on visual observation the red colour was hidden by the subsequent appearance of chlorophyll. Molecular analysis for the characterization of key enzymes in the flavonoid biosynthesis is in progress.

1340–1440
S06–P–7
THE DEVELOPMENT OF COMPOUND PRODUCT OF *EUCOMMIA ULMOIDES* OLIV.

Chang-gen Lu, Ning Sheng, Wei-lin Li, Shan-an He*

The Jiangsu Provincial Key Laboratory for Plant Ex Situ Conservation, Institute of Botany, Jiangsu Province and The Chinese Academy of Sciences, Nanjing, Jiangsu, China, 210014

Eucommiae (*Eucommia ulmoides* Oliv.), an endemic family with single genus and species in China, has a long (over 2000 years) history to be used as an important Chinese traditional medicinal material. Based on a large numbers of research works at botany, chemical and pharmacology carried out by both east and west scientists since 1950, it is recognized that Eucommiae has effect to invigorate the liver and kidney, strengthen the tendons and bones, lower blood pressure, lower the level of blood lipid, benefit vital energy, preserve essence, nourish skin and keep young, resist tiredness, buildup body immunity and promise longevity. The functional components in the cortex and leaves are lignans, flavonoids, chlorogenic acid and so on. Under the views of sustainable utilization of resources and integrated medical effect, authors developed a compound product of Eucommiae – DUZHONG CHONGCAO Capsule which was made of the extracts of leaves of Eucommiae, Chinese caterpillar fungus (*Cordyceps sinensis* (Berk) Sace) and other Chinese traditional medicinal materials. The pharmacological results examined by authoritative department show that this capsule has a bright future because of its remarkable effect to lower the level of blood lipid, resist tiredness and nourish skin and keep young.

1340–1440
S06–P–8
MEDICINAL HERBS–EAST MEET WEST

Thomas S.C. Li*

Pacific Agri-Food Research Centre, 4200 Hwy 97, S., Summerland, BC, Canada, V0H 1Z0

In spite of the great advances of modern scientific medicine, traditional herbal medicine is still the primary form to treat diseases for the majority of people in developing countries, including China. During the past decade, market demand for Chinese herbs has increased sharply in the West. To meet this huge demand, a mass collection of varieties of herbs from their natural habitats is inevitable and resulted in some species become threatened. Chinese herbal medicine generally uses either the whole plant or crude extracts, which tend to include a wide range of chemical constituents. By contrast, conventional western prescription drugs usually contain a single-molecule active ingredient to treat a single ailment. In a recent survey, hundreds of Chinese medicinal herbs commonly used can be found in natural havitats in North America, which have a phyletic relationship with either the same species or the same genus. Some of the principal ingredients in Chinese herbs can be extracted from related plant species in the West. Thus, it may be possible to substitute Chinese herbs with more readily available herbs in the West. Moreover, these North American plants are, or can be, cultivated, harvested and processed under proper management that will ensure their safety, quality, and efficacy.

1340–1440
S06–P–9
SOME NUTRO-CHEMICAL PROPERTIES OF MEDICINAL AND AROMATIC FOOD PLANTS IN NIGERIA—A TROPICAL ENVIRONMENT

S.O. Nwokoro*[1], H.O. Nwokoro[2]

[1]Nutritional Biochemistry Unit, Dept. of Animal Science, Faculty of Agriculture, Univ. of Benin, Benin City, Nigeria; [2]Earth Crust Global Coy Ltd., P. O. Box 7641, Shomolu, Lagos, Nigeria

The major sources of food seasonings and basic medicants in most rural Nigerian set ups are usually derived from plants (aromatic and medicinal). Some of these reasonable numbers of wild plants have sweetening, seasoning, therapeutic and nutritional values. It is thus not an over emphasis that consumers today are becoming increasingly conscious of the health and natural aspects of their foods. Their tendency now is to avoid chemicals and synthetic foods and choose therapy and nutrition through natural resources. Consequently, this paper examined 20 of such plants that have been identified and isolated in Nigeria especially with respect to their nutritional and basic chemical properties as conditioned by their tropicalised environment and in the sustainability equation.

1340–1440
S06–P–10
MORPHOLOGICAL AND CHEMICAL EVALUATION ON *HYPERICUM PERFORATUM* AND *H. MACULATUM* IN LITHUANIA

Jolita Radusiene*[1], Edita Bagdonaite[1], Saukius Kazlauskas[2]

[1]Institute of Botany Zaliju ezeru 49 LT-2021 Vilnius Lithuania; [2]Faculty of Farmacy Kaunas Univ. of Medicine Mickeviciaus 9 LT-3000 Kaunas Lithuania

The increasing demand for *Hyperici herba* has caused the evaluation of this genus in all Europe. *Hypericum perforatum* and *H. maculatum* are common species in Lithuania. The aim of the investigations was to examine indigenous populations of these species in respect to morphological characters and chemical constituents. The results of evaluation revealed high morphological diversity in both species. The cluster analysis distinguished three morphological types of *H. perforatum* populations. The width of leaves was the most discriminating character in the populations. The relation between the content of naphtodianthrones and the morphological type of populations was detected. The broad-leave type was characterized by higher amount of hypericin and pseudohypericin. The flavonoid content appeared to be more constant character in both species. The results indicated that wild populations of Hypericum are a potentially important source for breeding and improvement of the cultivated varieties.

1340–1440
S06–P–11
ETHNOBOTANY IN GALICIA (NW SPAIN): MEDICINAL USE

M.P. González-Hernández*, M.A. Rodríguez Guitián, A. Rigueiro Rodríguez, R. Romero Franco*

Dept. Crop Production. E.P.S. Univ. of Santiago de Compostela, Campus Lugo, 27002-Lugo. Spain

In Galicia, the same as in other western cultures, "traditional medicine" or phytotherapy has been substituted through the years by the modern medicine. Thus, the natural products used as remedies for curing processes in the past have been replaced very often by drugs derived from chemical synthesis. However, there are testimonies of natural remedies transmitted from generation to generation. Since we are attending the recover of natural medicine, we sought to collect those testimonies and prevent their lost. In this study, we show how the use of medicinal plants in the popular culture still remains in rural areas of Galicia. We have polled rural residents which preserve this knowledge as heritage from their ancestors, recording the common name and the portion/s of the plants used for this purpose, as well as the way of preparation, application and their specific recommendations. From this source, we learned of about 50 plant species across 26 different botanical families, mainly indigenous, that are utilized as medicinal remedies for human and domestic animals. We have also checked their therapeutic properties. Data from phytopharmacies have been recorded to verify which of these plants are the most demanded by the society, this proving the wide acceptance of remedies based on indigenous and exotic plants such as *Ginkgo biloba* L., *Echinacea angustifolia* D.C. and *Panax ginseng* C.A. Meyer.

1340–1440
S06–P–12
ANTI-INFLAMMATORY EFFECT OF HONEYSUCKLE (*LONICERA CAERULEA* L.) FRUIT

Gh. Mladin*[1], Maria Chirila[2], Paulina Mladin[1]

[1]Fruit Research Institute Pitesti-Maracineni, 0300 Pitesti, Arges, Romania; [2]S.C. Naturalia S.R.L.–Bucharest, Romania

The fruit extracts of blue honeysuckle fruit of 8 selections were tested in chemilight on polimorphonuclear leukocytes (PMN) collected of the peripheral blood of healthy individuals at that time. The oxidative metabolism of PMN leukocytes was measured by chemilightmetric technique luminally dependent on automatic chemilightmeter–Wallace 1251. The reaction system consisted of: luminal (50 µL) cell, cultural medium (350 µL) and zymogen (fruit extract) 1:10. Reaction intensity for each sample (milivolts–mv) was read and recorded for 30 minutes. Following the studies employed, a rather light variability of intensity in releasing the oxygen reactive species (ORS) among the normal individuals was observed. The fruit extract of "SL-75" blue honeysuckle selection has come off which strongly reduced the intensity of ORS releasing (toxic for the body) by PMN leukocytes, that have shown their strong antioxidant action. It is explainable for some individuals giving blood who might be infection carries (dental granuloms, laryngeal infection, viruses, etc). The blue honeysuckle (*Lonicera caerulea*) fruit, either fresh or processed may be used as a prophilaxy against the various factors generating toxic ORS (food additives, water and air pollution, radiation, stress, etc.) which are responsible to many chronicle, degenerescence or even neoplasmic diseases.

1340–1440
S06–P–13
MADAGASCAN ROMATIC PLANTS: ESSENTIAL OILS, ANTIOXIDANT AND ANTIMICROBIAL ACTIVITIES

Hector R. Juliani*[1], MM Roland Ramboatiana[2], Olivier Behra[3], Alison Garvey[4], Ilya Raskin[4], James E. Simon[4]

[1]ASNAPP-USA and the New Use Agriculture and Natural Plant Products Program, Rutgers Univ., New Brunswick, NJ, USA;[2]Phael Flor, Antananarivo, Madagascar; [3]C.B.D., Antananarivo, Madagascar; [4]New Use Agriculture and Natural Plant Products Program, Rutgers Univ., New Brunswick, NJ, USA

Essential oils from aromatic plants have been known since antiquity to possess biological activity, mainly antibacterial, antifungal and antioxidant properties. With growing interest in the use of essential oils in both the food and the pharmaceutical industries research has shifted into examining new applications for essential oils. Part of our Agri-Business in Sustainable African Natural Plant Products Program (ASNAPP, www.asnapp.org) seeks to identify new uses and applications of African natural products including essential oils and botanicals in order to both enhance their industrial and commercial uses and to ascertain potentially new human health applications for these products. The major aroma constituents, analyzed by GC/MS, of *Ravensara anisata* were methylchavicol (90%), *R. aromatica* were sabinene (10.7%), limonene (17.3) and methylchavicol (11.2%), *Ocimum basilicum* oil, linalool (59%), eugenol (8%) and limonene (6%), and other *O. basilicum* variety (methychavicol 85%). cinnamom bark (*Cinnamomum zeylanicum*), cinnamaldehyde (38%). The cinnamom leaf essential oils were rich in eugenol (59%–64%) and the highest content of eugenol was found in clove bud oil. The antioxidant assay showed that the highest activity was observed in clove bud oil, follow by the cinnamon leaf oils and linalool basil oil showing a lower activity. The antimicrobial activity showed that clove bud was the most active against *Pseudomonas aeruginosa* (less than 2 µL of essential oil/mL caused visual inhibition of growth), cinnamon bark showed the same activity against *Sacharomyces cerevisae*, and cinnamon leaf and clove bud oils also inhibited the growth of *Staphyllococus aureus* in the same amount. Within these essential oils, the clove bud oil appears most promising for potential food applications because of its antimicrobial and antioxidant activity and because this oil did not contain safrole, a component with a weak hepatotoxic, carcinogenic and mutagenic potential.

1440–1520
S06–O–14
PODOPHYLLOTOXIN CONTENT IN LEAVES OF EASTERN RED CEDAR (*JUNIPERUS VIRGINIANA*)

M. Maqbool*[1], K.E. Cushman[1], R. Moraes[2], P.D. Gerard[3]

[1]North Miss. Res. & Ext. Ctr., Mississippi State Univ., PO Box 1690, Verona, MS 38879, USA; [2]National Center for the Development of Natural Products (NCNPR), School of Pharmacy, Univ. of Mississippi, Univ., MS 38677, USA; [3]Dept. of Experimental Statistics, Mississippi State Univ., PO Box 9653, Mississippi State, MS 39762, USA

Eastern Red Cedar (*Juniperus virginiana*) contains podophyllotoxin, a compound used in the manufacture of drugs in the treatment of cancer, rheumatoid arthritis, genital warts, psoriasis, and multiple sclerosis. The objective of this study was to investigate variation in podophyllotoxin content in leaves of *J. virginiana* due to plant type and time of year. Plants of four different plant types were sampled: juvenile, immature, mature male, and mature female. Juvenile plants less than a meter in height had juvenile and mature tissue on the same plant. Only juvenile tissue was sampled. Immature plants about 2 meters in height had no juvenile tissue and had not yet expressed male or female sexuality. Mature plants more than 2 meters in height were easily identified as male or female. Samples of 100 grams or greater of fresh tissue were collected every month beginning in April 2001 as follows: one composite sample of juvenile tissue was collected from juvenile plants. Four samples were collected from immature plants, each from a different plant. Two samples were collected from male plants and two from female plants, each from a different plant. Samples were taken to NCNPR and dried, extracted in chloroform, and analyzed with HPLC to measure podophyllotoxin content against known standards. Two to four subsamples were analyzed from each sample. Data were analyzed with SAS using the mixed model for analysis of variance with repeated measures. Podophyllotoxin content ranged from a low of 0.5 mg/g to a high of 1.8 mg/g and was not greatly affected by plant type ($P = 0.14$) or time of year ($P = 0.20$). There was no significant interaction ($P = 0.20$).

1520–1540
S06–O–14–A
TO BE ANNOUNCED

1540–1600
S06–O–15
THE BOTANY AND ECOBOTANY OF VANILLA

Daphna Havkin-Frenkel*[1], Fulya Eren Pak[1], Jim French[2]

[1]Biotech Center, Rutgers the State Univ. of New Jersey New Brunswick, NJ; [2]Plant Biology and Plant Pathology Dept., Rutgers the State Univ. of New Jersey New Brunswick, NJ

Vanilla flavor is obtained from the fruit of Vanilla planifolia, a tropical climbing orchid originating in Mexico. Vanilla is the most popular and the most widely used flavor by both dollar and tonnage criteria. Vanilla was a source of flavoring and used by the Aztec emperors who used vanilla to flavor a cocoa drink, which in

the present day is hot chocolate. Vanilla was introduced to Europe following Cortez's conquest of the Aztec kingdom in 1519. Vanilla extract is obtained by ethanolic-water extraction of cured vanilla beans. Beans are harvested green and cured in high-heat high-humidity conditions to release vanillin and other flavor compounds from their precursors. Vanilla extract contains 250 or more compounds. Chief among them is vanillin, the most abundant flavor component. In the inner part of the bean around the seed cavity are special hair-like cells that are believed to produce vanillin and related compounds and excrete it to the space around the seed. The outer part of the bean contains the hydrolytic enzyme. During the curing process, the inner precursor combines with the outer part of the bean that contains the hydrolytic enzyme. Growing vanilla in different parts of the world results in different types of beans due to the varied growing and curing processes which will be featured.

1600–1620
S06–O–16
PHARMACOLOGICAL EXPERIMENTS OF FOUR CHINESE TRADITIONAL MEDICINAL PLANTS ON LOWERING BLOOD GLUCOSE LEVELS IN MICE

Wei-lin Li*[1], Ju-lan Wu[2], Bing-ru Ren[2], Rong-lin Guo[2], Ai-ling Zhou[2], Shan-an He[2], Han-chen Zheng

[1]Qianhu Houcun 1, Outside Zhongshan Gate, Nanjing, Nanjing, Jiangsu, China, 210014; [2]The Jiangsu Provincial Key Laboratory for Plant Ex Situ Conservation, Institute of Botany, Jiangsu Province and The Chinese Academy of Sciences, Nanjing 210014, Jiangsu; [3]College of Pharmacy, The Second Military Univ., Shanghai 200433

Pharmacological experiments of *Gynura divaricata* O. Hoffm., *Agrimonia pilosa* Ledeb., *Prunella vulgaris* L., *Ligustrum lucidum Ait.* and *Ilex cornuta* Lindl. et paxt. on lowering blood glucose were carried out. The water and ethanol extracts of *G. divaricata* have remarkable effect on lowering blood glucose level to both normal and alloxan diabetic mice, the dose 0.4 g (crude drugs)/kg of the water extract has equivalent effect as 50 mg/kg glyburide, and the dose 0.4 g (crude drugs)/kg of the 95% ethanol extract has more effect than 50 mg/kg glyburide on lowering blood glucose level to normal mice, the dose 2.0 g (crude drugs)/kg of the 95% ethanol extracts has equivalent effect as 100 mg/kg phenformin on lowering blood glucose level to alloxan diabetic mice. The dose 60 g (crude drugs)/kg of the boiled water extract of *A. pilosa* has equivalent effect as 50 mg/kg glyburide on lowering blood glucose level to normal mice, and the 95% ethanol extract has remarkable effect on lowering blood glucose level to alloxan diabetic mice. The dose 120 g (crude drugs)/kg of the 95% ethanol extract of *P. vulgaris* and the dose 22.5 g (crude drugs)/kg of the 95% ethanol extract of *L. lucidum* have remarkable effect on lowering blood glucose level to alloxan diabetic mice. The BuOH extract of *I. cornut* had not been found to have effect on lowering blood glucose level to both alloxan diabetic mice and normal mice. *G. Divaricata* is a good material to be utilized to develop medicines for diabetes mellitus.

1620–1640
S06–O–16–A
TO BE ANNOUNCED

1640–1700
S06–O–16–B
TO BE ANNOUNCED

Tuesday · August 13

1100–1140
S06–O–17
STANDARDIZATION OF HERBAL MEDICINAL PRODUCTS

Dennis V.C. Awang*

MediPlant Consulting, Inc., 15876 Thrift Avenue, White Rock, British Columbia V4B 2M8, Canada

Consumers and health professionals alike are justifiably apprehensive about the quality of commercial herbal medicines, classified as "dietary supplements" in the United States. North America lacks any governmentally administered program for controlling the identity and quality of botanically-sourced raw materials and plant-based commercial products. The choice of an herbal product from the plethora of competing brands is essentially an act of faith in the ethical integrity and scientific competence of the grower/supplier/fabricator/manufacturer continuum. Only through great effort can consumers learn which companies are scientifically and technically competent, experienced with the preparation of particular phytomedicines, and whose products are supported by clinical and other experimental data. Physicians who wish to use botanical medicines want to be assured of consistently high quality, efficacious products, and comparable responses from the same dose of an herbal product. With herbal products, however, the identity of the plant's active principle(s) is/are rarely clearly established. Herbs contain hundreds of compounds, often ranging between extremes of hydrophilicity and lipohilicity. In herbal medicine, an herb's actions are usually recognized long before mechanism of action and active principles are understood. Often, numerous constituents are active to different degrees and in various respects. There is relatively little research in this complex area; characteristically, advances in research cause emphasis to shift among the wide variety of classes of compounds, as well as their individual components. Extensive chemical characterization of clinically efficacious preparations currently appears to be the only sensible path towards establishing a reliable basis for quality control and advancing the expectation of consistent pharmacological response. The development of convenient reliable bioassays, correlated with clinical response, should also be pursued to complement chemical profiling.

1140–1200
S06–O–18
ASSESSMENT OF ONTARIO-GROWN GINSENG (*PANAX QUINQUEFOLIUS* L.) FOR NUTRITIONAL QUALITY AND FOOD SAFETY

C. Chung-Ja*[1], H.P. Jackson[1], V. Rupasinghe[1], J. Schooley[2]

[1]Guelph Center for Functional Foods, Laboratory Services, Univ. of Guelph, Guelph, Ontario, Canada N1H 8J7; [2]Ontario Ministry of Agriculture, Food and Rural affairs, Simcoe, Ontario, Canada

The natural health products industry is in need of standardardization criteria to assess the quality of herbals/botanicals for the international market. Presently, grading and pricing of the ginseng roots are determined based on the physical appearance of the roots. To initiate development of standardization criteria for ginseng, twenty representative samples of four-year-old ginseng roots were collected from Ontario, Canada and were analyzed for a wide range of nutritional and food safety parameters in an ISO 9002 registered laboratory. Proximate analysis revealed that ginseng roots contained 8 to 12% proteins, 0.3 to 1.2% fat, 67 to 80% carbohydrate, and 3 to 8% ash on dry weight (DW) basis. Ginseng contained 16 to 30 % dietary fibre. The calculated energy value of Ginseng was 340±6 kcal. Total ginsenosides concentration in roots ranged from 53 to 94 mg/gDW while ginsenosides Rb1 and Re contributed up to 70% of the total ginsenosides. Among the micro-nutrients K (12 to 16 mg/g DW), Ca (1 to 6 mg/g DW) and P (2 to 4 mg/g DW) were the predominant. Several other elements such as Na > Fe > Mn > Zn > B > Cu > Se were present in trace amounts as indicated descending order. Metalloid or heavy metals Cd, Cr, Hg, Mo, Ni, and Pb were not detectable in ginseng roots. The pesticides Quintozene, Iprodione and Zineb were detectable in some samples and the levels were variable. However, Chlorothanil and Metalaxyl were not detectable. *E. coli* and total Coliform counts of roots were in acceptable range. The aerobic bacteria, yeast and mold counts did not exceed the levels for self-stability. A comprehensive standardization procedure to assess the quality of ginseng roots is being developed.

1200–1220
S06–O–19
PHYSICOCHEMICAL AND PHYTOCHEMICAL STUDIES OF THE DYE FROM *HIBISCUS SABDARIFFA* L.—A POTENTIAL PHARMACEUTICAL DRUG COLORANT

F.P. Builders[1], O.O Kunle*[1], B.B Toge[1], O.F. Kunle[2]

[1]Dept. of Pharm. Tech and Raw Mat. Dev., National Inst. for Pharm. Res. and Dev. (NIPRD), PMB 21, Abuja, Nigeria; [2]Dept. of Med. Plant Res. and Trad. Med., National Inst. for Pharm. Res. and Dev. (NIPRD), PMB 21, Abuja, Nigeria

The water and methanol extracts of the calyces of the plant, Hibiscus sabdariffa

were subjected to phytochemical and physicochemical analysis. The extracts, which had intense red color even at 1:200 dilution, were found to have similar properties. The phytochemical analysis showed the presence of glycosides, flavonoids, balsams and sterols. Positive reactions indicating the presence of monosaccharides, free reducing sugars, combined reducing sugars and ascorbic acid were also observed. Qualitative TLC analysis using n-butanol: acetic acid: water (7:3:1) showed the presence of four different compounds for the water extract and five for the methanol extract. A sixth that was neither present in the water nor the methanol extracts was present in the AGC obtained from the hexane: ethyl acetate (50: 40 to 20: 40) fraction. The dye extracts had a pH of 2.5 and showed stability up to a pH of 4.5, above which the dye turned blue. Both extracts were stable to sunlight, air and preservatives. The extracts turned blue in the presence of alkalizing and oxidizing agents, however no color change occurred in the presence of acidifying agents, sodium chloride and potassium chloride. Spectrophotometric absorption spectrum of the extracts gave two relevant peaks with the maximum absorbance occurring at 290 nm and 325 nm for the water and methanol extracts respectively.

1220–1240
S06–O–20
POLYPHENOL, MINERAL ELEMENT CONTENT AND THE TOTAL ANTIOXIDANT POWER OF SAGE (*SALVIA OFFICINALIS* L.) EXTRACTS

M. Then[1], R. Szöllosy[2], K. Szentmihályi*[3]

[1]Semmelweis Univ., Faculty of Pharmacy, Dept. of Pharmacognosy, 1085 Budapest, Ülloi út 26, Hungary; [2]Dept. of Genetics and Molecular Biology, Univ. of Szeged, Szeged, Hungary; [3]Chemical Research Center, Hungarian Academy of Sciences, H-1525. Budapest, P.O. Box 17, Hungary

The alcoholic and aqueous extracts of *Salvia officinalis* L. leaves were studied for element composition, polyphenol content and antioxidant properties. The procedure of the alcoholic extract preparation was different from the conventional tincture preparing and it was amplified with extraction in ultra sound wather bath. The plant material was treated (infused) with the water proportion of the tincture-solvent (alcoholic solution of 20% and 40%), then the alcohol-part (of tincture-solvent) was added to the cooled aqueous extract. Element concentrations of the samples were determined by inductively coupled plasma atomic emission spectrometry. The phenol carbonic acid (rosmarinic-, caffeic-, chlorogenic- and ferulic acid) content was measured by TLC-densitometry. The highest amount of caffeic acid and rosmarinic acid were observed in macerated extracts made from 2 and 5 g leaves with 40 % alcohol. The mineral element content showed significant differences in the extracts prepared in diverse ways. The aqeous extract, prepared by infusion, showed the highest tannin content (310 mg/100 mL), the conventional tincture contained 166 mg/100 mL of tannin. The flavonoid content was 58 mg/100 mL in conventional alcoholic extract and 136 mg/100mL infused extract. The total antioxidant power was found to be significantly different in the different extracts which was measured by the FRAP assay.

1340–1440
S06–P–21
ESSENTIAL OIL COMPOSITION OF *ALOYSIA TRIPHILLA* (L'HERIT) BRITTON LEAVES CULTIVATED IN BOTUCATU, SÃO PAULO, BRAZIL

Roseane Oliveira de Figueiredo*[1], Mirian Baptista Stefanini[2], Lin Chau Ming[2], Marcia Ortiz Mayo Marques[3], Roselaine Facanali[3]

[1]Dept. of Botany Biosciences Institute, São Paulo State Univ., Botucatu-SP- Brazil, P.O.Box 510, Zip Code 18618-00; [2]Dept. of Plant Production–Horticulture, Agronomical Sciences College, São Paulo State Univ., Botucatu-SP-Brazil, P.O. Box 237, Zip Code 18603-970; [3]Pytochemystry Section, Agronomical Institute of Campinas, Zip Code 13075-630, Campinas -SP- Brazil

The family *Verbenaceae* comprises around 175 genus and 2,300 species, distributed in the tropics and subtropics, mainly the temperate zone of Southern Hemisphere. Lemon verbena (*Aloysia triphilla*) it is a perennial plant, arbustive and original of South America. Its essential oil is utilized in the pharmaceutical, cosmetic and perfumery industry. Its therapeutic actions include febrifuge, sedative, stomachic, diuretic, and antispasmodic activities. The present work had as objective to identify the chemical composition of the essential oil of *A. triphilla* leaves. The study was carried out in the Lageado Experimental Farm of the Dept. of Plant Production–Horticulture, Agronomical Sciences College, São Paulo State Univ.–Campus of Botucatu. Leaves of lemon verbena from Medicinal and Aromatic Plants Garden, were collected in the end of Winter (September 2001). The essential oil was extracted by hydro-distillation, in Clevenger apparatus. 100g of leaves were used in each extraction. Four extractions were done, during three hours. The essential oils of the leaves were analyzed in Gas Chromatography Mass Spectrometry (CG-MS, Shimadzu, QP-5000), equipped with capillary column DB-5 (30 m x 0.25 mm x 0.25 mm), split 1/35, injector for 220 C, detecting for 230 °C, drag by gas He (1,0 mL/min),with programmed temperature of 60 °C a 240 °C, 3 °C/min. The identification of the substances was made by comparison of its spectra of masses with the bank of the CG-MS (Nist 62 lib), literature and index of retention of Kovats. The main constituents of essential oils were geranial (29.54%), neral (27.01%), limonene (15.93%), geranyl acetate (4.0%) and geraniol (3.96%). This species posses high quantity of monoterpenes and low quantity of sesquiterpenes.

1340–1440
S06–P–22
COMPOSITION OF CORIANDER ESSENTIAL OIL FROM BRAZIL

Roseane Oliveira de Figueiredo*[1], João Nakagawa[2], Lin Chau Ming[2], Márcia Ortiz Mayo Marques[3]

[1]Dept. of Botany- Biosciences Institute, São Paulo State Univ., Botucatu-SP- Brazil, P.O.Box 510, Zip Code 18618-00; [2]Dept. of Plant Production, Agronomical Sciences College, São Paulo State Univ., Botucatu-SP-Brazil, P.O. Box 237, Zip Code 18603-970; [3]Pytochemystry Section, Agronomical Institute of Campinas, Zip Code 13075-630, Campinas -SP- Brazil

Coriander (*Coriandrum sativum* L.) is an annual and herbaceous plant, belonging to the Apiaceae family. Native of Southern Europe and Western Mediterranean region, this herb is cultivated all around the world. Its fruits (commonly called "seeds") are used for flavoring candies, beverages, tobacco products and in cookery. Coriander essential oil, largely used in perfumery and soaps. It's rich in linalool, and has great potential for industrial uses. This species has potential as medicinal plant, as well as source of essential oil. Its has been used as analgesic, carminative, digestive, depurative, anti-rheumatic and anti-spasmodic. The aim of this study was to analyse the chemical composition of the essential oils of the seeds of this species cultivated in Botucatu, São Paulo, Brazil. The experiment was carried out in Lageado Experimental Farm, Dept. of Plant Production, Agronomical Sciences College, São Paulo State Univ. The fruits were harvest 108 days after sowing. The essential oils were extracted by hydro-distillation, in Clevenger apparatus. 50 g of fruits were used in each extraction. Three extractions were done, during three hours. The essential oils were analyzed in Gas Chromatography Mass Spectrometry (CG-MS, Shimadzu, QP-5000), equipped with capillary column DB-5 (30 m x 0.25 mm x 0.25 mm), split 1/20, injector for 240 °C, detecting for 230 C, drag by gas He (1,7 mL/min), with programmed temperature of 40 °C (5 min) -150 °C, 4 C/min; 150 °C 280 °C, 8 °C/min. The identification of the constituents was made by comparison of their spectra of masses with the bank of the CG-MS (Nist 62 lib), literature and index of retention of Kovats. The 18 most important components were identified and quantified. The main components of the oil were linalool (77.48%), gamma-terpinene (4,64%), alpha-pinene (3.97%), limonene (1.28%), geraniol (0.64%) and 2-decenal (0.16%).

1340–1440
S06–P–23
VARIATION OF GLUCOSINOLATES LEVELS AMONG THIRTY-TWO ACCESSIONS OF HORSERADISH CULTIVARS

M. Kushad*, J. Juvik, B. Klein, M. Wallig, E. Jeffery, S. Chakravarthula

Univ. of Illinois Urbana, Illinois 61801

Glucosinolates are â-thioglucosides found mainly in *Brassicaceae*. At least 120 glucosinolates have been isolated from various *Brassicaceae*; however, only about 20 have been detected in *Brassica* vegetables. The function of glucosinolates in plants include protection against diseases and insects. Recent studies have also shown that glucosinolates have health promoting properties. Glucosinolate breakdown products have been shown to protect against various types of cancers including stomach and cholorectal cancers. Horseradish (*Armoracia rusticana* Gaertn. Mey., & Scherb.) is a member of the Brassicaceae. Evaluation of glucosinolate distribution in thirty-two accessions of horseradish from a germplasm collection at Univ. of Illinois showed that sinigrin is the dominant glucosinolate ranging in concentration from 84.6 to 258 µmol/g dry wt. Other glucosinolates found relatively high concentration in horseradish include

glucbrassicin (0.0 to 57.5 μmol/g dry wt.) and napoleiferin (2.1 to 64.1 μmol/g fresh wt.) The highest sinigrin was found in accession 810A, the highest napoleiferin was detected in 244 A, and the highest glucobrassicin was detected in 753A. Accession 753A is the standard commercial cultivar in Illinois. In addition to having the highest concentration of glucobrassicin, it also contained the third highest sinigrin concentration and tenth highest napoleiferin concentration. In contrast, accession 1890, which is another popular commercial cultivar, had the second and third lowest sinigrin and napoleiferin concentrations, respectively, and a modest amount of glucobrassicin. Variation in glucosinolate levels in horseradish suggests that the potential health and allelopathic response are greatly dependent on the accession selected. The wide range of variation among the accessions offers an important information base for developing accession with enhanced human and plant health benefits.

1340–1440

S06–P–24

A RAPID METHOD TO ANALYZE SAPONIN PRECURSORS IN SOYBEAN (*GLYCINE MAX*)

H.P. Vasantha Rupasinghe*[1], Chung-Ja C. Jackson[1], Vaino Poysa[2], Junei Kinjo[3]

[1]Guelph Center for Functional Foods, Laboratory Services, Univ. of Guelph, Guelph, Ontario, Canada N1H 8J7; [2]Greenhouse and Processing Crops Research Center, Agriculture and Agri-Food Canada, Harrow, Ontario, Canada N0R 1G0; [3]Faculty of Pharmaceutical Sciences, Fukuoka Univ., 8-19-1 Nanakuma 814-0180, Japan

The presence of saponins in soybean has attracted considerable interest over the last decade due to their biological properties owing to health benefits and adverse sensory characteristics. Group A acetylated saponins present in soybean, are implicated as the compounds mostly responsible for the bitter taste of soybean while group B and E saponins have chemoprotective properties. A rapid and efficient analytical method was developed utilizing HPLC equipped with evaporative light scattering detector (ELSD) to distinguish two major saponin components in soybeans; the aglycon soyasapogenol A contributing to the undesirable taste and soyasapogenol B representing group B and E saponins. Aqueous ethanolic extraction (80% v/v) yielded the highest recovery of saponin from finely ground soybean powder and produced no artifacts during hydrolysis to generate soyasapogenols compared with other extraction procedures. A complete hydrolysis of soyasaponins was achieved with 8% HCl in anhydrous methanol by incubating at 75 C for 3 h. Resultant soyasapogenols were isolated using C18 solid phase extraction. Chromatograms of high resolution were obtained with ODS C18 column at a flow rate of 0.9 mL/min with a mobile phase of acetonitrile:1-propanol:water: 0.1% acetic acid in 80:6:13.9:0.1 ratio. The calibration curves generated by ELSD for soyasapogenols were quadratic and the recoveries of soyasapogenol A and B were over 80 and 95%, respectively. To determine the distribution of soyasapogenol A and B in soybean, ten advanced food-grade soybean lines were grown in 1999 at four locations in Ontario under standard agronomic practices. In general, total soyasapogenol content was 0.2% on fresh weight (FW) basis and soyasapogenol B content was 3-fold higher than soyasapogenol A content (479 ± 72 μg/gFW). A significant variation in soyasapogenol content was observed among the cultivars tested.

1340–1440

S06–P–25

COMPOSITION AND CHEMICAL VARIATION OF CONSTITUENTS OF THE ESSENTIAL OIL POGOSTEMON PATCHOULI DURING DAYTIME PELLET LEAVES

M.A.S. da Silva*[1], P.A.D. Ehlert[1], M.O.M. Marques[2], L.C. Ming[1]

[1]Departament of Plant Production–Horticulture Sector, College Science, Botucatu, São Paulo, Brazil. P.O Box 237, 18603-970; [2]Phytochemistry Section, Campinas Agronomical Institute, Campinas, SP, Brazil CEP 13075-630

The medicinal effect of the patchouli (Pogostemon patchouli Pellet) is associated the action antiseptic, being used for headaches, fever and in the eczema treatment and acne. Its essential oil is constituted of benzoic aldehyde, eugenol, aldehyde cinamic and alcohol patchoulol. To verify the composition and the chemical variation of its essential oil along 24 hours, leaves of patchouli of medicinal collection plants of the Dept. of Vegetable Production/Horticulture of UNESP-Botucatu–SP, were collected every three hours during one day (of the 06.00 to 03:00 h), between November 25 and 26, 2000. The leaves had its oil extracted for hydro-distillation, in Clevenger apparatus for 3 hours with two replications. The chemical composition analyses of the extracted essential oils was carried out using gas chromatography/mass spectroscopy (CG-MS, Shimadzu, QP-5000). The identity of the volatile oil constituents was made through the comparative analyse of the mass of spectra of the substances with the database of the system GC-Em (nist 62.lib), literature and retention index. The profile phytochemical of the essential oils didn't present significant difference in function of the harvest. The five most abundant compounds included: a major sesquiterpene (59.44 to 65.22%) not yet identified, alpha-bulnesene (5.37 to 7.66%), alpha-guaieno (3.80 to 5.73%), patchoulene (2.54 to 3.36%) and another sesquiterpene (5.58 to 7.44%) also not identified. In bibliographical rising was detected divergences in relation to the majority component and to patchoulol, an alcohol sesquiterpene. We did not observe the presence of eugenol and patchoulol.

1340–1440

S06–P–26

COMPOSITION OF ESSENTIAL OIL OF ENDEMIC SARDINIAN CITRUS FRUIT "SA POMPIA"

M. Usai*[1], M. Marchetti[2]

[1]Dipartimento di Scienze del Farmaco, Università degli Studi di Sassari, Via Muroni 23/A, 07100 Sassari, Italy; [2]Istituto per l'Applicazione delle Tecniche Chimiche Avanzate ai Problemi Agrobiologici–CNR, Via Vienna 2, I-07100 Sassari, Italy

Citrus oil of very complex composition are contained in oval, balloon-shaped oil sacs or vesicles located in the outer rind or flavedo of the fruit. All essential oils, in particular those of citrus fruits, have been studied either for their economical importance or for scientific purpose. Many investigators have shown that the quality of citrus oils is dependent on several factors such as soil, climate, method of extraction of the oil, weather, and maturity and variety of the fruit. In our study we investigated the essential oil of an endemic citrus named popularly "sa pompia" that is not jet clear if it is a grape-fruit or a citron but it is known that it is present in Sardinia since 1500. It is used to prepare candied fruit boiling the rind into honey. In our study we followed the analytical variation of the essential oil during fruit maturation and we observed that the composition is characterized by a very high content of limonene (81.9%), with few constituents reaching 1%. We found 2.17% of b-myrcene and that the citral could be divided into neral 3% and geranial 3.9%. With these compounds we found also the corresponding alcohols, nerol 1.4% and geraniol 2.0%. All the other compounds were lower than 0.5%. The variations during the maturation period are not very evident.

1340–1440

S06–P–27

WHOLE PLANT OILS FROM *PISTACIA LENTISCUS* L. GROWING WILD IN SARDINIA

M. Usai*[1], M. Marchetti[2]

[1]Dipartimento di Scienze del Farmaco, Università degli Studi di Sassari, Via Muroni 23/A, 07100 Sassari, Italy; [2]Istituto per l'Applicazione delle Tecniche Chimiche Avanzate ai Problemi Agrobiologici–CNR, Via Vienna 2, I-07100 Sassari, Italy

Pistacia lentiscus L. together with the strawberry-tree, phillyrea and rosemary are plants that long ago were part of the Mediterranean spot of Sardinia. Lentisk is unmistakable for its scent, has usually a shrubby form that, in wind absence, has roundish shape but, in our Island, as it happens for other small bushes, are present magnificent, true exemplary and own trees. Lentisk, for its dissemination in all Mediterranean area, was famous also in ancient Greece where it was one of the plants more used for its multiple officinal and alimentary qualities. Beyond to this druggist use, from the Lentisk, until to some decades ago, with boiling and squeezing of the drupe a fuel oil was obtained and when the alimentary resources were lacking, always from the squeezing of the fruits came outside an olive oil substitute, the lentisk can aromatize wines and liqueurs and its mastication aid the salivary secretion. In our study we analyzed the chemical composition of acetone extract from *P. lentiscus* L. The primary product of the acetone extraction was partitioned between hexane and ethanol in order to separate the oil fraction. *P. lentiscus* L. produced only a small amount of oil 1.1% to 1.7%. The polyphenolic material was not further analyzed. Saponification of the oil fraction afforded a 52% of unsaponifiable and a 45% of

saponifiable matter. This last one is the most interesting material in the oil as a source of fine chemicals. The oil showed an interesting composition of the fatty acid mixture where linoleic acid (26%), linolenic acid (18.5%) and palmitic acid (11.5%) were the more represented. Hydrocarbon fraction showed an original composition where the C15 chain was the more represented and the constituents remembered more essential oil compositions than classic hydrocarbon fractions. Free phytol was present in large amount together to sitosterol, campesterol and stigmasterol.

1340–1440
S06–P–28
PHYTOCHEMICAL STUDY ON *CISTUS CRETICUS* SUBSP. CORSICUS (LOISEL.) GREUTER ET BURDET GROWING WILD IN SARDINIA

M. Usai*[1], M. Marchetti[2], A. Atzei[1]

[1]Dipartimento di Scienze del Farmaco, Università degli Studi di Sassari, Via Muroni 23/A, 07100 Sassari, Italy; [2]Istituto per l'Applicazione delle Tecniche Chimiche Avanzate ai Problemi Agrobiologici–CNR, Via Vienna 2, I-07100 Sassari, Italy

Cistus genus (Cistaceae) are between the more diffuse shrubs in Sardinia because they are typical members of the Mediterranean and pioneer plants who disseminates itself also on lands covered from the fire or in marginal lands. Also being plants very diffuse their chemical composition is not deepened known if we except some resins. The use of these plants, to part rare exceptions, from the herboristic point of view is made only on the effect of the extracts and knowing insufficient the active principles to which ascribing these actions. In the popular medicine of some countries the rubberize-resin, obtained from *C. creticus* ssp. creticus L. is used, like balsamic-expectorant, revulsive and emmenagoghe. This oleoresin finds uses also in pharmacy, like emetic, antiasthmatic, in the cure of the ulcer, and against the fall of hairs. In our study we investigate the whole-plant oil and the essential oil composition of Cistus creticus subsp. corsicus (Loisel.) Greuter et Burdet growing wild in Sardinia. The primary product of the acetone extraction was partitioned between hexane and ethanol in order to separate the oil fraction C. creticus ssp. creticus produced 5.3% oil. The polyphenolic material was not further analyzed. Saponification of the oil fraction afforded a 46% of unsaponifiable and a 43% of saponifiable matter. This last one is the most interesting material in the oil as a source of fine chemicals. The oil showed an interesting composition of the fatty acid mixture where linoleic acid (21%), and palmitic acid (17.5%) were the more represented. Hydrocarbon fraction showed a composition where the C20, C26 and C28 chains were the more represented. The essential oil presents a interesting composition in which the major contituent has a structure that look likes the totarene compound.

1340–1440
S06–P–29
STUDY ON ESSENTIAL OIL AND FREE MENTHOL ACCUMULATION IN 19 CULTIVARS, POPULATIONS, AND CLONES OF PEPPERMINT (*MENTHA* X *PIPERITA*)

Stanko Stanev*[1], Zheljazkov (Jeliazkov) Valtcho[2]

[1]Research Institute for Roses, Aromatic and Medicinal Crops, Kazanluk, Bulgaria; [2]Dept. of Plant and Animal Sciences, Nova Scotia Agricultural College, PO Box 550, Cox Build. 151-8, Truro, Nova Scotia, B2N 5E3, Canada

Bulgarian peppermint oil also known as 'Bulgaro-Mitcham' is famous as one having the finest quality. Being the main constituent of the oil, menthol is a targeted compound in the selection and breeding process. Menthol is represented in the oil as free form (menthol, iso-menthol, and neo-menthol), or in associated form (menthyl acetate). A two year field experiment was conducted to study the essential oil and menthol productivity of 19 cultivars and population of peppermint. The aim of the investigation was to evaluate the available peppermint material obtained through various breeding methods with respect to further selection and breeding by using two indices: 1) intensity of essential oil synthesis (as the necessary dry herba for obtaining of 1 g of essential oil); and 2) intensity of menthol synthesis and accumulation (as the necessary dry herba for obtaining of 1 g of menthol). The highest essential oil content in dry herba was measured in two varieties: 'Dulgo pole' (2.5%), and 'IO native form' (2.9%). For these two forms, the necessary dry matter for obtaining 1 g essential oil are 40 and 34 g respectively. The highest menthol content was established in the oils from cultivars Zefir, Dulgo pole, and Clone 11-6-22 and Clone 80-121-33.

1340–1440
S06–P–30
SELECTIONS OF LONICERA CAERULEA L. FOR A POTENTIAL UTILIZATION IN FOOD INDUSTRY AND PHITOTHERAPY

Gh. Mladin*[1], Eliza Oprea[2], Mihaela Bratu[2], Paulina Mladin[1]

[1]Fruit Research Institute Pitesti-Maracineni, 0300 Pitesti, Arges, Romania; [2]Faculty of Medicine and Pharmacy "Ovidius" Univ., 8700 Constanta, Romania

Since 1988 studies on breeding valuable genotypes of *Lonicera caerulea* have carried on at the Fruit Research Institute Pitesti-Maracineni. By frequent crosses and selfpollination, in the 2nd and 3rd generations, 12 big-fruited genotypes (3-4 cm) were developed. Their fruit are edible and suitable both for fresh market and processing for the food industry. By the lab analysis of the blue honeysuckle (*Lonicera caerulea*) fruit, 5 classes of active factors were identified: carotenes (ß carotene: 20.05-33.08 mg/g), anthocyanins (250-560 mg%), flavonoids, ozenae, poliholoids. However, the fruit of this selection lack in the alcaloids, commarines, saponins, tannins and cardiotonic heterosides. The quantitative measurements of *Lonicera* fruit displayed a rich content in antioxidant components as well as in ascorbic acid (66.4-107.5 mg%), anthocyanins, carotenoids and flavones, give the fruit by their sinergic action not only a nutritive value but a therapeutic one as an antioxidant factor in the human body function. Under Romanian pedoclimatic conditions, *Lonicera caerulea* selections have shown a very early growth season, a flower resistance to -5-70 °C and a fruit ripening of 1-2 week earlier than strawberry. The plants produced fruit in 2-3 years after planting (1.5 kg/bush). In a 4 years period since crop establishment, *Lonicera* selections matched the soil quite well; they grow and develop well on loam-sandy soils, sometimes on clay soils with a 5-7 pH and the sunny sites

1440–1500
S06–O–31
EFFECT OF POPULATION AND ROOT AGE ON GINSENOSIDE CONTENT OF AMERICAN GINSENG (*PANAX QUINQUEFOLIUM*)

Kenneth W. Mudge*[1], Wasang Lim[1], Joeseph Lardner[2]

[1]Dept. of Horticulture, 25 Plant Science Building, Cornell Univ., Ithaca, NY 14853; [2]Dept. of Horticulture, Kenneth Post Laboratory, Cornell Univ., Ithaca, NY 14853

American ginseng (*Panax quinquefolium*) is valued in traditional Asian medicine, and its use in Western countries has increased in recent years. The value of artificially-cultivated ginseng is much lower than that of woods-cultivated or wild-collected ginseng, but populations of the latter are threatened throughout its range. Our goal is what factors influence the concentration of the pharmacologically active ginsenosides. Age-related increase in ginsenosides have been reported by several authors but variation among wild populations has not been considered. Ginsenoside analysis via HPLC was performed on roots collected from 8 different NY State populations. Statistical analysis of the effects of population and age on ginsenoside content indicated that there was a significant effect of both on ginsenoside Rc, a significant interaction between population and age for ginsenosides Rb1 and Rb2, and a significant three way interaction between population, age and root fresh weight for Re. Ginsenosides Rb1 and Rb2 increased with age for some populations but not for other populations. We conclude that the prevailing generalization that ginsenosides increase with root age cannot be applied to wild North American ginseng without taking into consideration population differences. The effects of population on ginsenoside content is likely to be related not only to environmental differences among collection sites but also genetic differences since there was considerable (several fold) variation in the content of ginsenosides within single populations. It is likely therefore that selection and cloning of individual roots for higher ginsenoside content could be a useful strategy for improvement of this medicinal crop. These results also suggest that populations could be selected based on their sensitivity to age and fresh weight-related increase in ginsenosides concentration.

1500–1520
S06–O–32
UTILIZATION OF MEDICINAL AND AROMATIC PLANTS

A. Susheela Thirumaran, S. Amutha*

Home Science College and Research Institute, Tamil Nadu Agricultural Univ., Madurai-625 104, Tamil Nadu, India

A study was undertaken to protect the stored paddy from insects using indigenous plant materials by non-mixing method. Powder of plant materials namely Senna leaves (*Cassia angustifolia*) Palmarosa leaves, (*Cymbopogon martini*) Dill seeds (*Anethum graveolens*). Omum seeds (*Carum copticum*) and whole kolinji plant (*Tephrosia purpurea*) were used as plant protectants. The active components of all the five plant materials were isolated by Thin layer chromotography (TLC) and further characterized usingGas chromotography- Mono spectrum (GC-MS) and High Performance Liquid Chromotography (HPLC). All the five were found to possess insect repellent property. The effective concentration was found to be one percent to that of the amount of grains stored. The storage studies carried out over a period of six months with these materials did not alter physical, chemical, milling and organoleptic characteristics.

1520–1540
S06–O–32–A
TO BE ANNOUNCED

1540–1600
S06–O–33
DRYING TEMPERATURE AND DEVELOPMENTAL STAGE AT HARVEST INFLUENCE THE PARTHENOLIDE CONTENT OF FEVERFEW LEAVES AND STEMS

James W. Rushing, Richard L. Hassell*, Robert J. Dufault

Clemson Univ. Coastal Research and Education Center 2865 Savannah Highway Charleston, SC 29414

Feverfew (*Tanacetum parthenium* L.) plants produced during the spring of 2000 and 2001 on raised beds and black plastic mulch in four replicated plots were harvested at four stages of development beginning at the early vegetative stage when plants were approximately 40 cm tall and stems were succulent. At approximately 14 day intervals harvest was repeated until the plants had begun to flower. Harvested tissues were dried with forced air at either 40, 60, 70, 80, or 90 °C until the moisture content was in the range of 8 to 10%. After drying, leaves and stems were separated and parthenolide was extracted and analyzed by high performance liquid chromatography. Drying temperature significantly influenced the amount of parthenolide recovered from dried tissues. Leaves dried at 40 °C had a mean parthenolide content of 0.43% (dry wt). This decreased linearly with increasing drying temperature, with approximately 25% less parthenolide following drying at 90 °C. Stems typically had one-tenth the amount of parthenolide found in leaves. Harvest date did not significantly influence the parthenolide content of leaf or stem but biomass production did increase as plants matured, therefore the amount of parthenolide produced per ha increased. Recommendations derived from this research were extended to commercial growers and the results of a pilot project with eight growers in 2001 will be reviewed.

1600–1620
S06–O–34
TAXONOMICALLY USEFUL CHIRAL VOLATILE MARKERS FOR DIFFERENTIATION OF CLOSELY RELATED AROMATIC PLANTS

U. Ravid*, N. Dudai, E. Lewinsohn, O. Larkov, L. Frieman

Dept. of Aromatic Plants, ARO, Newe Ya'ar Research Center PO Box 1021, Ramat Yishay 30095, Israel

The significance of enantiomers as chemical markers within species is demonstrated by chiral monoterpene hydrocarbons and oxygenated monoterpenes detected in fresh herbs such as *Origanum majorana, O. syriacum, O. dayi, O. vulgare, O. ramonense, Rosemarinus officinalis, Salvia fruticosa* and *S. officinalis*. The characterization of the species or hybrids is important for the taxonomic distinction, as well as for a reliable assessment of the quality of aromatic plants. The enantiomeric composition of essential oil components such as camphor, limonene, _-pinene, _-terpineol, cis- and trans-sabinene hydrate, cis- and trans-sabinene hydrate acetate and others is of pivotal importance for chemotaxonomic implications. A chiral monoterpene may show differences in enantiomeric composition when appearing in closely related aromatic plant species and their hybrids. This enables us to differentiate herb cultivars. The enantiomeric composition of chiral volatile monoterpenes was determined in fresh aromatic plants by method headspace-solid phase microextraction-chiral gas chromatography-mass spectrometry.

1620–1640
S06–O–34–A
TO BE ANNOUNCED

1640–1700
S06–O–34–B
TO BE ANNOUNCED

Thursday · August 15

1100–1140
S06–O–35
PRODUCTION, TRADE, AND ECOLOGICAL MANAGEMENT OF MEDICINAL AND AROMATIC PLANTS

Dagmar Lange*

Univ. of Landau, Institute of Biology, Landau, Germany

Medicinal and aromatic plants play a critical role in the healthcare of populations in developing countries and in western countries. Thus, the global importance of this plant material is enormous, resulting in a huge trade on a national and international level. During the 1990s, the reported annual international importation of pharmaceutical plants (SITC. 3 commodity group 292.4) amounted on average to 400,000 metric tons valued at USD 1,243 million. This international trade is dominated by a few countries with over 80 percent of the global import and export allotted to 12 countries each. Whereas Japan and Korea are the main consumers of pharmaceutical plants, China and India are the world's leading producing nations. Hong Kong, the USA, and Germany standout as important trade centers. Until now, the wild-collection of medicinal and aromatic plants has played a significant role in the production of the demanded raw materials. Utilization and commerce of wild plant resources are not detrimental in themselves, but the increasingly global nature of trade, the world's population growth, and the herbal renaissance in the industrial nations has resulted in an increasing demand for raw materials. The global import of pharmaceutical plants doubled from 269,000 metric tons to over 500,000 metric tons in the 1990s, threatening some plant populations. The threat to medicinal plants from over-collection is not a new phenomenon (observed since the Roman period), but today the intensive commercial collection is often concentrated in a few areas with largely unmonitored trade, destructive harvesting techniques, altered trade structures (primarily in countries of the former Eastern Bloc), and unregulated global habitat loss and alterations, producing incomparable growing pressure on plant populations in the wild. Such conditions, if continued, may result in over-harvest of wild populations and a decline in genetic diversity. In the case of medicinal plants, conservation policies and practices have to meet future supply needs and provisions for species conservation. On an international and/or national level, protective measures range from species conservation programs, cultivation practices, process shifting from consumer to source countries, and resource management to trade restrictions or even trade bans. Finally, medicinal and aromatic plants are of high priority for conservation action, as wild-crafting will certainly continue to play a significant role in the future. The commercial use of biological resources may be a financial incentive for conservation measures.

1140–1200
S06–O–36
INVESTIGATIONS INTO THE SOIL CONDITIONS ASSOCIATED WITH WILD-OCCURRING BLACK COHOSH (*CIMICIFUGA RACEMOSA*) POPULATIONS IN PENNSYLVANIA: IMPLICATIONS FOR SUCCESSFUL AGROFORESTRY CULTIVATION

Eric P. Burkhart*

Dept. of Horticulture, The Pennsylvania State Univ., 102 Tyson Building, Univ. Park, PA, USA, 16802

The genus *Cimicifuga* (Ranunculaceae) contains 23 taxa distributed throughout two continents. Recent biochemical and clinical research has succeeded in demonstrating the efficacy of several taxa in treating various pre-menstrual, menopausal, and gynecological conditions. Publicity from such studies has also succeeded in stimulating international commerce in the rhizome. This has, in turn, fueled concern over extirpation of wild populations. None of the taxa of *Cimicifuga* are cur-

rently cultivated on a commercial scale. Field studies throughout Pennsylvania over the past three years have been conducted to determine the specific soil attributes of wild occurring *C. racemosa* following the premise that such studies should provide an indication of the preferred soil textural and nutrient characteristics necessary for successful horticultural production. Soil samples have been collected from wild populations found growing throughout the various geologic provinces of Pennsylvania and assayed for chemical and physical properties. Results obtained from this study indicate that there are several consistent soil traits between populations, despite biotic and abiotic differences. These include a proclivity for high pH sites, soils with high calcium levels, and loamy textural properties. With respect to calcium, these data suggest that the use of amendments such as limestone and/or gypsum to increase soil pH and/or calcium levels may improve plant performance under cultivation. Limestone and calcium amendments have been shown elsewhere to improve the growth of other novel agroforestry crops such as American ginseng, thus lending support to this notion. Further research should seek to test this hypothesis through replicated growing trials.

1200–1220
S06–O–37
FEASIBILITY OF CULTIVATING CALENDULA AS A DUAL PURPOSE INDUSTRIAL OILSEED AND MEDICINAL CROP

Ron Wilen[1], Manjula Bandara[2], Branka Barl*[1], Al E. Slinkard[1]

[1]Dept. of Plant Sciences, Univ. of Saskatchewan, Saskatoon, Saskatchewan S7N 5A8; [2]Crop Diversification Centre South, Brooks, Alberta T1R 1E6 Canada

Calendula (*Calendula officinalis* L.) flowers have been used for centuries for their anti-inflammatory and wound healing properties. More recently, calendula seeds were found to contain calendic acid (octadeca-8:10:12-trienoic acid), the rapidly oxidizing fatty acid with applications in the plastics, paint and coating industries. Two commercially available cultivars of calendula in North America, Resina and Erfurter Orangefarbigen, were evaluated for the feasibility of production as a dual purpose crop in Western Canada. Results from a two-year study indicated that both cultivars produce a reasonable seed crop on the prairies, if planted by mid-May at 6 kg/ha at 1.25 to 2.50 cm depth. Good weed control with no damage was provided by Edge and Poast Ultra. Resina was a higher seed-yielding variety (781 kg/ha) than Erfurter Orangefarbigen (562 kg/ha). Under dryland farming conditions, seed oil of both cultivars contained 45–50% of calendic acid, which was an acceptable level for industrial application. However, seed oil content was significantly lower (2-5%) than reported in the literature (10-20%). Calendula flowers collected for medicinal application after August 10 had no effect on seed yield. Cultivar Erfurter Orangefarbigen contained up to 30% more flavonoids based on the isorhamnetin-3-rutinoside and isorhamnetin-3-O-2-rhamnosyl-rutinoside content. The content of flavonol glycosides showed a decreasing trend from mid-August to mid- September in both years. It is concluded that calendula shows a good potential as a specialty crop for Western Canada, providing cultivars with higher seed oil content similar to those reported in the literature, could be made available.

1220–1240
S06–O–38
AEROPONICS: AN ALTERNATIVE PRODUCTION SYSTEM FOR HIGH-VALUE ROOT CROPS

A.L. Hayden*[1], G.A. Giacomelli[2], T. Yokelson[3], J.J. Hoffmann[4]

[1]Native American Botanics Corporation, PO Box 44287, Tucson, AZ 85733 USA; [2]Dept. of Agricultural & Biosystems Engineering, Univ. of Arizona, PO Box 210038, Tucson, AZ 85721 USA; [3]Nutritional Laboratories, International, PO Box 1657, Lolo, MT 59847 USA; [4]Southwest Center for Natural Products Research & Commercialization, Univ. of Arizona, 250 E. Valencia, Tucson, AZ 85706

An aeroponic system was developed for the production of root crops used as raw materials for the herbal and phytopharmaceutical industries. The variability in the phytochemical quality of botanicals produces inconsistent products and precludes the ability to administer uniform dosing in clinical studies. Aeroponic systems allow the producer to precisely control root zone nutrient and water regimes and environmental conditions, as well as have complete access to the roots throughout the life of the crop. An A-frame aeroponic system was designed to maximize root yields and permit free access to the roots for monitoring. Burdock (*Arctium lappa*, Asteraceae) plants were grown in aeroponics with controls grown in a greenhouse soilless mix for ten weeks in a research greenhouse in Tucson, Arizona. The plants were harvested and the dry weights of above ground parts and roots were determined, as well as the chlorogenic acid concentration in the dried roots. Chlorogenic acid is a caffeoylquinic acid derivative known to have antioxidant activity. The chlorogenic acid concentration of several commercial burdock root preparations were also determined and used as benchmark values. A second crop of burdock was grown for six months in the same aeroponic system and the root biomass and chlorogenic acid yields were determined. The second crop grew from seeds obtained from different seed sources to ascertain if phytochemical variation might be due to variation within the species. The biomass yields of the above ground (aerial) parts were significantly higher in the aeroponically grown plants compared to the controls. The root biomass yields showed no significant difference between treatments. The chlorogenic acid concentrations were also not significantly different, however the plant-to-plant variability was significantly lower in the aeroponically grown plants, suggesting the potential for more consistent phytochemical yields using this production technique.

1340–1440
S06–P–39
GROWTH AND HARVEST INDEX (CULTURAL YIELD) OF SAFFRON UNDER ZANJAN CONDITIONS: EFFECT OF SOWING DATE AND DEPTH

Emad Bozorgzadeh*, Mohammad E. Amiri

Dept. of Horticulture, Univ. of Zanjan, Zanjan, Iran

In a cormy plant species with a well-defined growth pattern such as saffron changes in corm size, sowing date, and plant depth each can alter the structure and bolting stem, thus impacting harvest yield. A 3-year study of summer sown (dormancy corm) saffron was conducted under rainfed Zanjan conditions in northwestern Iran to determine the influence of sowing depth and sowing date on harvested yield. Three sowing depths (10, 20, and 30 cm) over two planting dates, early summer and mid-summer were evaluated in a randomized completed block design with four replications. Between- year variation had more effect on growth indices than on flowers (filament) yield.

1340–1440
S06–P–40
THE EFFECT OF LIGHT INTENSITY AND NITROGEN ON PLANT GROWTH AND LEAF QUALITY OF NGO GAI (*ERYNGIUM FOETIDUM* L.)

Clare Casey*, Frank Mangan, Stephen Herbert, Anne Carter, Allen Barker, and Wesly Autio

Dept. of Plant and Soil Sciences, Univ. of Massachusetts, Amherst, Massachusetts, USA, 1003

Eryngium foetidum L. is a culinary and medicinal leafy green herb commonly used throughout the West Indies, Central America, West Africa, and many Asian countries. This plant is widely cultivated in Costa Rica, Trinidad and Tobago, and Puerto Rico for local consumption and export to the United States. Plants grown under shade produce larger and greener leaves that are more marketable because of their more supple texture and pungent aroma. A replicated trial was implemented in 2001 to evaluate the effect of light regimes and nitrogen on the growth and leaf quality for commercial production in Massachusetts. Plants were started in a greenhouse and transplanted to the field on black plastic. There were five light intensities: 0, 20, 40, 60, and 80% shade created by placing shade cloth over plants. For each light intensity, there were three rates of nitrogen applied to plants in split application as NH_4NO_3: 0, 45, and 90 kg·ha^{-1}. The weight of flower stalks, removed from all plants on a weekly basis, decreased in a statistically significant trend with the decrease in light intensity. With an increase in shade there was a dramatic decrease in leaf weight and leaf number; however, there was also a concomitant increase in the leaf area by weight. Plants produced with 0 or 20% shade were considered unmarketable due to a lack of leaf suppleness.

1340–1440
S06–P–41
PLANTING DATE AND DENSITY UPON THE YIELD OF TURMERIC

A.B. Cecílio Filho*[1], R.J. de Souza[2], V. Faquin[3], L.T. Braz[1]

[1]Dept. of Crop Production, Via de Acesso Prof. Paulo Donato Castellane, s/n, Jaboticabal-São Paulo, Brazil; [2]Dept. of Agriculture,Universidade Federal de Lavras, Lavras-MG, Brazil; [3]Dept. of Soils, Universidade Federal de Lavras, Lavras-

MG, Brazil

The experiment was carried out in the Universidade Federal de Lavras, in Lavras, Brazil. The objetive was to determine the best combination of the factors for maximization of the yield of turmeric. The experimental design used was randomized complete blocks, in split-plot, with three replications. The factors evaluated were: planting date (20 Oct., 20 Nov., 20 Dec. and 20 Jan.) and spacing between plants in the plantation line (20, 35 and 50 cm), amounting to 12 treatments. Rhizomes production per plant showed with a great deal of resemblance the growth characteristics and nutrient accumulation, reaching 673.13 g/plant, in the 20 November planting and 36.6 cm spacing. However, the maximum rhizomes yield (24,678.82 kg/ha) was reached in the plantation of 20th Nov. and spacing of 30 cm between plants, spacing that also provided the greatest leaf area index (2,3). This yield, due to the experimental conditions, corresponds to an increment of 363% in the Brazilian average productivity.

1340–1440

S06–P–42

CLOVE-BASIL PRODUCTION AND ESSENTIAL OIL YIELD AS AFFECTED BY ORGANIC FERTILIZATION AND HARVESTING SEASONS

F.C.M. Chaves*[1], L.C. Ming[1], D.M. Fernandes[2], Marques Meireles[3]

[1]Plant Production Dept., Agron. Sci. College, Sao Paulo State Univ., Botucatu, SP, Brazil, Experimental Farm Lageado, P.O. Box 237, Zip Code 18.603-970, Brazil; [2]Dept. of Natural Resources, Sao Paulo State Univ., Botucatu, SP, Brazil, Experimental Farm Lageado, Brazil; [3]Phytochemistry Section, Agronomical Institute of Campinas, Campinas, SP, Brazil

The harvest of medicinal plants, mainly shrubs through out the year is associated with climatic conditions and cultivation management such as fertilization and time of harvesting. *Ocimum gratissimum* L. is a bush of African origin, which grew voluntarily in Brazil. The leaf of the plant contains essential oil rich in eugenol used in the pharmaceutical industry. The objective of this work was to verify the production of leaves, stems, inflorescences, essential oil and their constituents as a function of seasonal application of organic fertilization. *Ocimum* plantlets were taken to the field in 90 days after sowing (January 2000). The treatments were four levels of hen manure (0, 4, 8, and 12 kg/m^2), which were applied 10 days after the transplantation. Plant spacing was 1.0 m between rows and 0.8 m between plants. A randomized block design was used with four replications. Plant harvest (30 cm above soil level) was done in May and August 2000. The leaves, inflorescences, and stems were separated and two samples dried at 60 °C for 3 days to obtain the dry weight. Two samples of 100 g of fresh leaves were used for essential oil extraction (Clevenger apparatus, during 3 h). The essential oils were analyzed by GC–MS. The levels of manure did not affect the production of leaves and stems and the total weight of the plants. There were significant differences inflorescence yield. These parameters, however, were significantly different in function of climatic seasons because the plants were 3 month older in the winter yield of inflorescences were significant when level 0 and 12 kg/m^2 of manure were used. There were no significant differences in essential oil yield of leaves and inflorescences of organic fertilization. However significant differences were observed in leaves yield in different harvesting seasons. The main constituents of leaves essential oil were eugenol, 1,8 * cineole and trans-caryophylene.

1340–1440

S06–P–43

CHARACTERISATION AND EVALUATION OF BORAGINACEAE SPECIES AS SOURCE OF GAMMA-LINOLENIC ACID (GLA) FOR MEDITERRANEAN CONDITIONS

Antonio De Haro*[1], Candido Galvez[2], Hava Rapoport[1], Belen Alcaide[1], Adoracion Cabrera[3]

[1]Instituto Agricultura Sostenible, IAS-CSIC, Alameda del Obispo S/N, Cordoba, Spain, 14080; [2]Semillas Silvestres, S.L., C/Aulaga nº 24, 14012 Córdoba. Spain; [3]Escuela Técnica Superior de Ingenieros Agrónomos, Córdoba, Spain

The Boraginaceae family includes a large number of Mediterranean species, many of them growing in during the winter and taking advantage of the available rains. Although borage (*Borago officinalis* L.) is the only species of the Boraginaceae used as source of gamma linolenic acid (GLA) for therapeutic and cosmetic purposes, this essential fatty acid is present in others species belonging to the same botanical family, some of them could be cultivated in the future as GLA source in the Mediterranean and rainfed conditions. A germplasm collection of Boraginaceae species has been constituted at the Institute of Sustainable Agriculture (Córdoba, Southern Spain) by collecting in Mediterranean wild populations and by exchanging with Botanical Gardens. This collection includes accessions of several species of *Anchusa*, *Echium*, *Cynoglosum*, *Nonea*, *Symphytum* and other genus, well adapted to Mediterranean conditions. Most of the accessions collected have been multiplied in field conditions at Córdoba, and evaluated for seed oil content and composition. The fatty acid composition of the seeds with special attention to GLA and erucic acid content, and the possibilities as new crops are discussed. Furthermore, the progress made in the genetic and microscopic studies of the two borage mutants developed by our group, showing seed retention and increased number of seeds, will be presented.

1340–1440

S06–P–44

INFLUENCE OF CULTURAL SYSTEM AND FERTILITY ON FEVERFEW BIOMASS AND MARKER COMPOUND CONTENT

Robert J. Dufault*, James Rushing, Brian Ward, Merle Shepard, Richard Hassell

Clemson Univ., Coastal Research Center, 2865 Savannah Highway, Charleston, SC 29414 USA

Feverfew (*Tanacetum parthenium* L.) was grown on bare ground with drip irrigation using low (60 kg N/ha) and high fertility (160 kg N/ha) and on black plastic mulch beds using high fertility (160 kg N/ha) to determine which system may enhance biomass and parthenolide concentration. Feverfew plants were harvested at vegetative, early bud, and full flower growth stages to determine when biomass and parthenolide are maximized. We evaluated green feverfew sources from Richter's (R) Seed Co., Ontario, Canada and Johnny's (J) Seed Co., Maine, USA and a golden (G) feverfew from Richter's. During the vegetative stage, biomass was greatest with J grown on mulch/high fertility followed by R on mulch. Biomass of bare ground plants grown with the same high fertility was significantly lower, indicating a positive benefit of mulch. These relationships continued through all later harvest stages. Parthenolide content at vegetative stage was highest with G feverfew on mulch/high fertility, yet fertility levels and mulch had no effect on J or R parthenolide content. By early bud stage, high fertility whether on bare ground or mulch, increased parthenolide in G feverfew, with neither fertility nor bare ground and mulch affected its concentration in R or J feverfew. By full flower stage, G feverfew remained vegetative and was not harvested because of inferior size in contrast to green feverfew. R green feverfew had significantly higher parthenolide in all systems than J feverfew. Fertility did not affect parthenolide of either R or J feverfew at full flower. We conclude that the best cultural system for growing feverfew with high biomass and parthenolide (mg/plant) was on mulch with high fertility and harvested in the vegetative stage.

1340–1440

S06–P–45

PHOTOSYNTHTIC, EVAPORATIVE AND LEAF MORPHOLOGICAL PROPERTIES OF STOCK GROWN UNDER ROOT RESTRICTION AS AFFECTED BY FERTIGATION FREQUENCY

Tanjuro Goto*, Kiyoto Haba, Yuichi Yoshida, Yoshihiro Kageyama

Faculty of Okayama University, Tsushimanaka 1-1-1, Okayama, Japan, 7008530

Experiment was conducted to clarify the effect of fertigation frequency (once or eight times per day) on growth, evapotranspiration rate and, photosynthetic and leaf morphological properties, of stock (*Matthiola incana* R. Br.) grown under restricted root zone volume (30, 100, and 300 mL). Shoot growth reduced with decrease in root zone volume, however, the growth reduction was smaller when the plants fertigated frequently compared to that of the plants fertigated only once a day. Although the evapotranspiration rate did not decrease when the plants fertigated frequently, the rate remarkably decreased when the total water consumption of the plants reached nearly equal to the water holding capacity of the medium (50% of the volume) in the plants grown in 30 or 100 mL containers. Size of stomata decreased with decrease in fertigation frequency or container size. Transpiration rate, net photosynthetic rate and leaf CO_2 concentration were remarkably lower in the plants grown in 30 and 100 mL containers fertigated once a day, compared to the other four treatments. The rate of photosynthesis and evapotranspiration of the plants fertigated 8 times a day was kept higher than those fertigated only once a day. Consequently, vegetative growth of the plants fertigated frequently was equal to or more vigorous than those grown with three

fold of root zone volume but fertigated only once a day.

1340–1440

S06–P–46

INFLUENCE OF TEMPERATURE ON THE GERMINATION OF VARIOUS SOURCES AND SEED SIZES OF *ECHINACEA PALLIDA*, *ECHINACEA PURPUREA*, AND *ECHINACEA ANGUSTIFOLIA*

Richard L. Hassell*, Robert J. Dufault, James W. Rushing, Tyron L. Phillips

Clemson Univ., Coastal Research Center, 2865 Savannah Highway, Charleston, SC 29414 USA

Seed was collected from 1-year-old mother plants, 2-year-old mother plants, and a purchased seed lot with parents age unknown. Seeds were sized using USA standard testing sieves selecting size 8 (seed that did not pass through 2.36 mm^2 screen), size 10 (seed that did not pass through 2.00 mm^2 screen), and size > 10 (seed passing through sizes 8 and 10). Two-year-old *E. pallida* mother plants produced the highest germinating seeds and the most vigorous seed. *Echinacea pallida* germination was the highest with the smallest size seed. The optimal temperature for highest germination was a range of 22 to 28 °C for *E. pallida*. One-year-old *E. purpurea* mother plants produced the most vigorous seed of highest germination. Medium seed (size 10) germinated better than the others with *E. purpurea* germination optimal over 22 to 30 C. Large seeds of *E. purpurea* consistently germinated poorly. One-year old plants germinated best at 28 to 30 °C while 2-year old mother plants require 30 to 32 °C for highest germination. *Echinacea angustifolia* seeds smaller than size 8 (large seed) did not germination at any temperature. Large seed of *E. angustifolia* germinated to the highest level at 28 to 30 °C.

1340–1440

S06–P–47

GROWTH OF LAVENDER (*LAVANDULA OFFICINALIS* CHAIX) AND ROSEMARY (*ROSMARINUS OFFICINALIS* L.) IN RESPONSE TO DIFFERENT MULCHES

Jeanet Hoeberechts, Silvana Nicola*, Emanuela Fontana

Università di Torino, Dip. AgroSelviTer, Via Leonardo da Vinci, 44, Grugliasco, TO, Italia, 10095

Weed control is a serious problem in the cultivation of Medicinal and Aromatic Plants (MAPs) because most of them are not successfully competitive with noxious plants. Being no herbicide registered for MAPs in Italy, other weed control techniques, such as plastic mulching, have to be adopted. The aims of the project were to verify the possibility of growing lavender (*Lavandula officinalis* Chaix) and rosemary (*Rosmarinus officinalis* L.) in a profitable way in the Sacra Valley (North-West of Italy); to control weeds by mulching, comparing this technique to an undisturbed situation (control), and to analyze the durability of different black mulches used (polyethylene, transpiring, draining types). Experiments in the field started on 31 May 2001, transplanting plants arranged in a grid spaced 0.6 x 0.6 m, in a loamy soil, provided of an overhead irrigation system with sprinklers. Experiments consisted of 2 species by 4 mulches treatments by 4 blocks. Periodical measurements of canopy height and diameter, and flowered branch counting were carried out to study plant growth. Weeds were identified and their development in the treatments was assessed in terms of density and covering. In the control plots, both lavender and rosemary suffered weed invasion: canopies developed more in height than in width in both species; lavender plants produced less flowers than plants in mulched plots. Polyethylene and transpiring mulches controlled 100% weeds; five months after transplanting mulches were still totally entire. Plants grown with these two types of mulches increased canopy height and width more than plants grown with the other treatments. Since from the beginning, the draining mulch was perforated by some weed species (*Setaria viridis* and *Echinochloa crus-galli*), which covered the mulch for about 50% at the end of the growing season. Results indicated that the best mulches to cultivate lavender and rosemary were polyethylene and transpiring types.

1340–1440

S06–P–48

EVALUATION OF MEDICINAL HERB SPECIES FOR KANSAS

Rhonda R. Janke*, Edward E. Carey

Dept. of Horticulture, Forestry, and Recreation Resources, 2021 Throckmorton, KSU, Manhattan, KS 66506 USA

An evaluation trial is being conducted to determine the feasibility of growing certain medicinal herb species commercially in Kansas. Seventeen species were evaluated at two sites in 2000 and 2001, and an additional 15 species were evaluated in 2001 at three sites. The sites include the Olathe Research Center in Eastern Kansas, the John C. Pear Research Center in Wichita Kansas (South-Central), and the Hays Research Center in Central/Western Kansas. All species were started from seeds in the greenhouse in the early spring, and transplanted to the field in late May or early June. Evaluations included height, vigor, insect, and disease ratings, above ground and below ground biomass, and survival. Replicated plots include 10 plants per plot at 1 ft in-row spacing (Olthe and Wichita) or 5 plants per plot at 2' spacing (Hays). Results show that some species that were expected to do well in Kansas, including *Echinacea* spp., performed rather poorly. Establishment and survival were poor for *E. angustifolia*, and *E. purpurea* had nearly 100% infection rate of aster yellows by the second year after planting. *Echinacea pallida* had intermediate survival and biomass production compared to the others, but would not be recommended as a crop unless the price was high and the labor to harvest the crop was available and not expensive. Another native species, *Asclepias tuberosa*, also performed rather poorly, with low vigor ratings and biomass production. Some introduced species yielded well the first year but not the second (*Chrysanthemum parthenium* and *Verbascum thapsis*), while others drastically increased their biomass production in the second year, and have the potential to become weedy invaders if not handled carefully (*Glycyrrhiza uralensis*).

1340–1440

S06–P–49

INFLUENCES OF IRON FERTILITY ON ELEMENTAL CONTENT, PIGMENTATION, AND PHYTONUTRIENT CAROTENOIDS AMONG KALE (*B. OLERACEA* ACEPHALA GROUP) CULTIVARS

Dean A. Kopsell*, David E. Kopsell

Dept. of Plant Biology, The Univ. of New Hampshire, G48 Spaulding Hall, Durham, NH 3824 USA

Iron (Fe) plays significant roles in chloroplast development and photosynthesis in plants. Plants grown under limited Fe have reduced chlorophyll pigmentation and show chlorosis. The xanthophyll carotenoids are accessory pigments that serve both light collection and photoprotective functions in photosynthetic processes of green plants. These antioxidant carotenoids may also serve as components of the protective macular pigment (MP) in human retinas. Research has shown MP levels to be directly related to dietary intake of vegetables. Diets rich in green leafy vegetables may protect against aging eye diseases such as cataract and age-related macular degeneration. Enhancing the xanthophylls in dietary vegetable sources may therefore reduce the risk and progression of aging eye disease, thus improving the quality of life for aging adults. Green leafy vegetables are major sources of these compounds in the diet, but the extent of environmental and genetic influences on carotenoid biosynthesis is not known. If carotenoid pigments protect chlorophyll from light damage, then carotenoid concentration may be affected by changes in chlorophyll levels. Three kale (*Brassica oleracea* Acephala Group) cultivars were greenhouse grown in modified Hoagland's nutrient solutions under 2.0, 1.0, 0.5, 0.25, and 0.125 mg Fe per L. Chlorophyll a ($P = 0.02$), chlorophyll b ($P = 0.02$), and the carotenoid ($P = 0.001$) pigments decreased in response to decreases in Fe fertility. The carotenoid pigments in 'Winterbor' ($P = 0.005$) and 'Bona' ($P = 0.02$) cultivars showed a significant quadratic response, increasing and then decreasing with decreases in Fe treatments. The mineral elements of N, P, S, Mg, Mn, Zn, and Fe responded significantly to decreasing Fe fertility. Changes in Fe fertility levels affected both plant pigments levels and nutrient content. Decreases in phytonutrient carotenoids under decreased Fe fertility would be expected to lower the nutritional value of kale.

1340–1440

S06–P–50

SODIUM HYPOCHLORITE AND ETHEPHON TREATMENT ENHANCES GERMINATION OF *ECHINACEA ANGUSTIFOLIA* SEED

Keun Ho Cho, In Sup So, Chiwon W. Lee*

Dept. of Plant Sciences, North Dakota State Univ., Loftsgard Hall 266F, Fargo, ND 58105 USA

The influence of sodium hypochlorite and ethephon on the germination of narrow-leaved purple coneflower (*Echinacea angustifolia*) was investigated. Treatment of seeds with ethephon (1 mM) for 2 hours followed by soaking in 10%

household bleach (clorox, 0.525 sodium hypochlorite) greatly enhanced germination (>90%). The treatment of seed with a combination of clorox and ethephon shortened number of days required to reach 50% of the final germination (T50) from 4.2 days in control to 1.1 days. Seedlings grown from ethephon-treated seeds had shorter and thicker radicles and greater dry weights compared to the control. The same trend was observed during seedling emergence from soil. Ethephon treatment longer than 2 hours resulted in weaker seedlings, probably due to leaf senescence. As the time of seed exposure to ethephon increased, anthocyanin content in seedling leaves increased linearly from 0.04 mg/g in control to 2.77 mg/g in 24-h treatment. Seed treatment with household bleach and ethephon may well be practiced to facilitate the establishment of *E. angustifolia* in the field.

1340–1440

S06–P–51

PLANT REGENERATION IN ECHINACEA ANGUSTIFOLIA FROM LEAF TISSUE CULTURES

In Sup So, Keun Ho Cho, Chiwon W. Lee*

Dept. of Plant Sciences, North Dakota State Univ., Loftsgard Hall Room 266C, Fargo, ND 58105 USA

Plant regeneration for narrow-leaved purple coneflower (*Echinacea angustifolia*) was investigated using seedling leaf tissues cultured in vitro. Cotyledon tissues of *E. angustifolia* seedlings were cultured on Murashige and Skoog (MS) medium supplemented with 0–5.0 mg/L naphthalene acetic acid (NAA) and 0–5.0 mg/L benzylamino purine (BA). Callus formation readily occurred when the medium contained greater than 0.2 mg/L NAA regardless of presence of BA. Callus was subcultured on MS medium containing 0–5.0 mg/L NAA and 0.2–5.0 mg/L BA with or without 0.5 mg/L paclobutrazol (PBZ) for 4 weeks. When medium contained PBZ, callus became compact and dense producing a large number of shoot primordia, especially when 5 mg/L BA was used. These compact calli, when subcultured on MS medium containing 0.2–5.0 mg/L BA without PBZ, produced multiple shoots. The number of shoots obtained per culture was highest (12.8 shoots/culture) when subculture medium contained 5 mg/L BA. Shoot formation also occurred directly from true-leaf tissues when precultured on MS medium containing PBZ. Shoots were divided and treated with 1,000 mg/L NAA, indolebutyric acid (IBA), or indoleacetic acid (IAA) as a quick dip method, and then subcultured on MS medium containing no growth regulators. While roots were formed on the shootlets receiving any of these auxins, highest rooting (92%) occurred when 1,000 mg/L IBA was used. Rooted plants were successfully established in soil growing medium in the greenhouse.

1340–1440

S06–P–52

RESEARCH ON INTRODUCE AND TRANSPLANT OF AROMATIC PLANTS FROM THE MEDITERRANEAN REGION TO HESHUO XINGJIANG AND SHANGHAI CHINA

Yao Lei*[1], Takanobu Shibata[2]

[1]Agricultural College Shanghai Jiao, 2678 Qi Xin Road, Shanghai, China, 201101; [2]34-583 Balatubo Ida-Cho Okazaki Aichi, Japan

The studies was designed to solve the problem, How to introduce and transplant aromatic plant from the Mediterranean region to Heshuo Xinjiang and Shanghai, China. These varieties included Lavender (*Lavandula angustifolia vera*), Thyme (*Thymus vulgaris*), Sage (*Salvia officinalis*), Clary sage (*Sage sclarea*), Hyssop (*Hyssopus officinalis*), Sweet Basil (*Ocimum basilicum*), Oregano (*Origanum vulgare*), and Marjoram (*Origanum majorana*). After investigating and analyzing the climate condition of these regions, we plant the same varieties on the Shanghai and Heshuo. Shanghai's latitude (31°10') is lower than Heshuo's (43), And Heshuo's latitude is approach the Provence's (44) of France. We observed the growing performance of these plants, determined content of essential oil. Our results show that Lavender and Hyssop are very suitable planted on Heshuo, Xinjiang, but not suitable on Shanghai. The growing performance of Thyme, Sage, Clary sage, Oregano, Marjorams are better in Xinjiang than those are in Shanghai. The content of essential oil of Sweet Basil in Xinjiang is higher than it is in Shanghai, even though its growth in Xinjiang is lower than it is in Shanghai . The following climate factors are very important for the aromatic plants to be introduced and transplanted successfully from Mediterranean region: same latitude and hours of sunshine of growing period, accumulative temperature, accumulative temperature and days, precipitation and humidity, and extent of solar radiation.

1340–1440

S06–P–53

LOW TEMPERATURE EXPOSURE AFFECTS REGROWTH POTENTIAL OF MAYAPPLE (*PODOPHYLLUM PELTATUM*) RHIZOME PROPAGULES

Muhammad Maqbool*[1], Kent E. Cushman[1], Rita Moraes[2]

[1]North Mississippi Res. & Ext. Center, Mississippi State Univ., P.O. Box 1690, Verona, MS 38879 USA; [2]National Center for the Development of Natural Products, School of Pharmacy, Univ. of Mississippi, Univ., MS 38677 USA

Podophyllotoxin is a natural lignan found in *Podophyllum* sp. This compound is the precursor of drugs used in the treatment of cancer, rheumatoid arthritis, genital warts, psoriasis, and multiple sclerosis. Podophyllotoxin is currently extracted from rhizomes of the Indian Mayapple, *P. emodi*, but is also found in rhizomes and leaves of the American Mayapple, *P. peltatum*. The objective of this study was to investigate methods of overcoming dormancy and apical dominance of rhizome segments of *P. peltatum* for subsequent use as propagules in greenhouse and field plantings. Two types of rhizome segments were harvested from the wild in Oxford, Mississippi, on 4 Dec 2000: one-node segments consisting of a dormant node subtended by 4–6 cm of internode (D) or two-node segments consisting of a terminal node and its adjacent dormant node (T+D). Segments were placed in the dark in a controlled-temperature chamber at ≈5 °C for 30, 45, 60, 75 or 90 days. After low temperature treatment, segments were placed in pots, one per pot, containing a commercial potting mix. Fifteen pots per replication were arranged in a greenhouse in a split plot design, with rhizome segment as the main plot and duration of exposure as the subplot. Shoot emergence and growth were recorded. Rhizome segment and duration of exposure significantly affected emergence and growth of mayapple shoots. Segment T+D exhibited significantly greater percent emergence, less days to emergence, and greater total leaf area and plant height than segment D. Increasing duration of exposure significantly increased percent emergence, decreased days to emergence, and increased plant height. There were significant interactions between rhizome segment and duration of exposure for days to emergence. In conclusion, type T+D rhizome segments exposed to 60, 75, or 90 days of ≈5 °C temperature exhibited greater emergence and growth than type D segments or when exposed to low temperature for less than 60 days.

1340–1440

S06–P–54

EVALUATION OF DEVELOPMENT OF FAFIA (*PFAFFIA GLOMERATA* SPRENG.) PEDERSEN

Lin Chau Ming*[1], Cirino Correa, Jr.[2]

[1]Fazenda Experimental Lageado S/N, Faculdade de Ciências Agronomicas, UNESP, Depart. Plant Production/Horticulture–Agronomical Sciences College, Sao Paulo State Univ.–Botucatu–SP–Brazil–CEP 18.603-970; [2]Emater–PR–Rua da Bandeira 500, Cabral, Curitiba, PR, Brazil, CEP 80035-270

The roots of *Pfaffia glomerata*, known popularly as Brazilian ginseng, are used in popular medicine in Brazil as tonic. The species occurs spontaneously at the margins and islands of Rio Parana, among the states of Parana, Sao Paulo and Mato Grosso do Sul (Brazil). The intensive collection of its roots put the species in risk of extinction. An experiment was installed in the municipal district of Querencia do Norte, Parana State. The aim of this experiment was to evaluate the development in height of the plants of four accessions (2 from Parana, one from Sao Paulo and one from Mato Grosso do Sul State). The experimental design was randomized blocks, with four treatments (accessions) and four replications. In each plot were planted 24 seedlings. Five evaluations of the height were accomplished, with an interval of two months, starting from the second month after planting of the seedlings. In the first evaluation, the accessions 1 and 2 presented inferior development when compared with accessions 3 and 4. From the second evaluation on there were not significant differences among the accessions. In the first interval the average growth was 216.97% (38.3 to 121.4 cm). In the second interval, the average growth was 28.74% (121.4 to 156.3 cm) and the plants reached their maximum development in height. At the end of the third and fourth intervals (end of summer and fall), there was a reduction in the average height, respectively, 153.1 and 151.2 cm. The maximum height reached was 156.3 cm. We concluded the fafia possesses a strong initial growth, with visible difference among the accessions in the first months. From the sixth month on, we observed a slight decrease in the height. This suggest the end of the annual cycle.

1340–1440

S06–P–55

EFFECT OF SEED SURFACE DISINFECTION TREATMENTS, ETHREL AND COLD STRATIFICATION ON THE GERMINATION OF *ECHINACEA ANGUSTIFOLIA*

Mohyuddin Mirza*[1], Muhammad Younus[1], Wanyu Chen[1], Adele Mandryk[2]

[1]Crop Diversification Centre North, R.R.6, 17507-Fort Road, Edmonton, Alberta, Canada, T5B 4K3; [2]The King's Univ. College 9125-50 St. Edmonton, Alberta, Canada T6B 2H3

Echinacea angustifolia is an important medicinal plant and its commercial production has been hampered due to poor seed germination. Several seed lots of varying ages were examined and the percentage germination ranged between 12 and 35% although 95% of the seeds were found to contain viable embryos. In this study effect of commercial bleach, hydrogen per oxide and ethanol was determined on the germination of *E. angustifolia* seed lots from Canada and U.S sources. The effect of cold stratification and exposure to ethrel from synthetic and natural sources was also examined. Surface sterilizing seeds with 0.5% sodium hypochlorite for 5 minutes reduced the fungal infection and significantly increased the germination. Ethanol was also found to be a satisfactory seed disinfection agent but it did not enhance the germination. A significant improvement in both rate and percentage germination was observed with cold stratification of 35 days in three seed lots, while it was non significant in one seed lot. Exposing the seeds to 400 ppm of ethrel from chemical source or to ethylene from apples significantly improved the germination when compared to nontreated seeds. The development of these methods have provided the growers an important tool to obtain high seed germination to grow plugs at large scale.

1340–1440

S06–P–56

IN VITRO PLANT REGENERATION FROM LEAF-DERIVED CALLUS IN GOLDENSEAL (*HYDRASTIS CANADENSIS*)

E. Bedir, H. Lata, R.M. Moraes*

NCNPR, School of Pharmacy, The Univ. of Mississippi, Univ., MS 38677 USA

Goldenseal (*Hydrastis canadensis* L., Ranunculacea) is a North American species with a folk medicine history for the treatment of gastrointestinal disturbances, urinary disorders, hemorrhage, skin, mouth, and eye infections, and inflammation. Currently, goldenseal is among the top 10 selling herbs in the United States for enhancing general body immunity. Goldenseal is wild crafted with an increasing demand and has been listed in Convention on International Trade in Endangered Species (CITES) Appendix II list. Tissue culture techniques have been used for propagation and conservation of endemic or endangered plants. We developed an in vitro propagation protocol for rapidly producing goldenseal plantlets from disk tissue of young leaves. These explants were inoculated on Murashige and Skoog's (MS) medium supplemented with various concentrations of NAA and TDZ for production of callus. Two-month-old calluses were subcultured on MS media containing cytokinins (BA, kinetin, TDZ) in different concentrations for shoot initiation. The optimum level of callus induction and maintenance was in 1.0 mg/L NAA in combination with 0.5 mg/L TDZ. Shoot multiplication was achieved on MS medium with 0.5 mg/L TDZ in combination with 0.1 mg/L NAA. Our results suggest that our in vitro propagation protocol will produce a positive impact in the conservation of *Hydrastis canadensis*.

1340–1440

S06–P–57

GROWTH AND YIELD OF CILANTRO FERTILIZED WITH COW AND SHEEP MANURES

Al-Mario Casimir, J. Pablo*, Morales-Payan*

1246 Fifield Hall, Horticultural Sciences Dept., Univ. of Florida P.O. Box 110690, Gainesville, FL 32611 USA

Experiments were conducted in order to compare the growth and yield of the seasoning/medicical herb cilantro (*Coriandrum sativum*) fertilized with sheep (*Ovis aries*) and cow (*Bos indicus*), as compared to standard chemical fertilizer. The study was conducted at the Nigua Experimental Station in San Cristobal, Dominican Republic. 'Longstanding' cilantro was established directly from seed in a loamy clay soil. The treatments consisted of 100 Kg N/ha supplied as chemical fertilizer (CF) (9–12–6.7–4.7 MgO–13 S), dry cow manure, dry sheep manure, a mixture of cow manure (50 Kg N/ha) and CF (50 Kg N/ha), and a mixture of sheep manure (50 Kg N/ha) and CF (50 Kg N/ha). A treatment with no fertilization was also included. Plant height, fresh and dry shoot biomass (yield), and leaf number were measured. Analysis of variance and Duncan's test (5% significance level) were performed on resulting data. Leaf number was not significantly different between treatments. At harvest, plants without fertilization were significantly shorter, but there were no significant differences in plant height between organic, chemical and mixed fertilizer treatments. Plants receiving chemical fertilizer or the mixture of sheep manure and CF had significantly higher dry and fresh yields (about 15%) than plants receiving either sheep manure or the mixture of cow manure and CF. With no fertilization, the yield was about 30% lower than with CF. These results show that, at least the first year, CF or mixture of sheep manure and CF provided higher yields. Also, the type of organic fertilizer could play a major role in cilantro yield. Because of the organic produce premium, cilantro fertilized with sheep manure was as profitable as cilantro with CF.

1340–1440

S06–P–58

FIELD PRODUCTION OF TEXAS NATIVE EVENING PRIMROSE (*OENOTHERA* SPP.) AS A SOURCE OF GAMMA LINOLENIC ACID

C.L. Murphy*[1], C.B. McKenney[2], D.L. Auld[1], N.W. Hopper[1]

[1]Dept. of Plant and Soil Science, Texas Tech Univ., Box 42122, Lubbock, TX 79409 USA; [2]Dept. of Plant and Soil Science (TTU) Texas Agricultural Extension Service (TAMU), 17360 Coit Road, Dallas, TX 75252–6599

Gamma Linolenic Acid (GLA) has been recognized as a beneficial treatment for a variety of human ailments including high blood pressure, cardiovascular disease, skin disorders, and diabetic neuropathy. *Oenothera biennis* has been the most widely used species of Evening Primrose to produce GLA. Over a period of two years, native accessions of *O. elata*, *O. jamesii,* and two accessions of *O. rhombipetala* were produced as transplants in a greenhouse and mechanically transplanted to the field in three different plant spacings. Plots were harvested and analyzed to determine seed yield, oil content and level of GLA in the oil. In the two years of this study, seed yield, oil content and levels of GLA were significantly impacted by plant spacing treatments. Generally, the higher plant populations gave the best results.

1340–1440

S06–P–59

SUSTAINABLE CROP MANAGEMENT PRACTICES FOR IMPROVING PRODUCTION OF CULINARY HERBS IN THE VIRGIN ISLANDS

M.C. Palada*[1], S.M.A. Crossman[2], A.M. Davis[1], C. Robles[2], E.A. Chichester[3]

[1]Agricultural Experiment Station Univ. of the Virgin Islands RR2, Box 10,000 Kingshill, St. Croix, Virgin Islands 00850 USA; [2]Cooperative Extension Service Univ. of the Virgin Islands RR2, Box 10,000 Kingshill, St. Croix, Virgin Islands 00850 USA; [3]Virgin Islands Dept. of Economic Development and Agriculture Estate Lower Love St. Croix, Virgin Islands 00850 USA

Small-scale vegetable growers in the Virgin Islands rely on sales of culinary herbs as one major source of income. In spite of the economic importance, culinary herbs are available only in local markets and do not constitute a significant export crop. There is little research information on sustainable crop management practices to improve production and marketing of herbs in the Virgin Islands. This project was undertaken to develop sustainable soil and crop management practices for culinary herbs using crop rotation with green manures, application of composts, animal manures, and mulching. Over a 4-year period (1997–2000), results indicated that although there were no significant differences in fresh and dry matter yield, culinary herbs grown in rotation with tropical green manure crops such as sunnhemp (*Crotolaria juncea*) and hyacinth bean (*Lablab purpureus*) tended to produce higher yields than those grown with cowpea (*Vigna unguiculata*) or fallow (no green manure) suggesting that without chemical fertilizers, legume green manure crops can sustain economic yield levels of culinary herbs in a crop rotation system. Organic mulches such as grass straw, wood chips and shredded paper were excellent alternatives to synthetic (plastic) mulch. Additionally, organic mulch suppressed weeds, increased irrigation water use efficiency, reduced soil surface erosion, and improved economic returns. Yield of thyme (*Thymus vulgaris*) was improved by application of chicken manure, but application of either cow manure or turkey litter did not influence yield of chive (*Allium schoenoprasum*), cilantro

(*Coriandrum sativum*), parsley (*Petroselinum sativum*), sweet marjoram (*Majorana hortensis*) and thyme.

1340–1440

S06–P–60

OXALIC ACID CONCENTRATIONS IN PURSLANE LEAVES ARE INFLUENCED BY THE STAGE OF HARVEST AND THE NITRATE TO AMMONIUM RATIOS IN HYDROPONICS

Usha R. Palaniswamy*[1], Bernard B. Bible[2], Richard J. McAvoy[2]

[1]School of Allied Health, U-2101, Univ. of Connecticut, Storrs, CT 06269 USA; [2]Dept. of Plant Science, U-4067 Univ. of Connecticut Storrs, CT 06269 USA

Purslane (*Portulaca oleracea*, Portulacaceae) has been identified as the richest terrestrial source of omega-3 fatty acid concentrations. However, the consumption of purslane as a green vegetable is limited by the possible harmful health effects of large amounts of oxalic acid concentrations reported in the leaves. In previous studies we reported the influence of nitrate to ammonium ratios in hydroponics on the leaf omega-3 fatty acid concentrations. The objectives of this study were to determine the effect of NO^{3-}-N: NH^{4+}-N ratio and the stage of harvest that would minimize the oxalic acid concentrations in purslane leaves. Twenty-one-day-old seedlings of purslane were transplanted into a closed hydroponic system. Treatments were arranged in randomized complete blocks design with five replications. There were six plants in each treatment replication. Nitrogen, at 200 mg·mL^{-1} was provided as nitrate (NO^{3-}) and ammonium (NH^{4+}) forms to yield NO^{3-}-N: NH^{4+}-N ratios of 1:0, 0.75:0.25, 0.5:0.5, and 0.25:0.75. Young, fully expanded leaves from five nodes from the shoot tip, were harvested at 8-true leaf stage and at 16-true leaf stage and analyzed for the oxalic acid concentrations. Results indicate that at both stages of harvest the oxalic acid concentrations were ≈40% to 50% lower in the leaves grown in nutrient solutions containing ammonium compared to the leaves grown with no ammonium. The leaves harvested at 16-true leaf stages had 20% to 40% lower oxalic acid concentrations compared to the leaves harvested at 8-true leaf stage. The leaves had 20% to 40% more oxalic acid concentrations than the stems. The dry weight (DW), fresh weight (FW) and the leaf area (LA) were greater at 16-true leaf stage of harvest than at 8-true leaf stage. However, at both the stages of harvest, the DW, FW, and the LA, were not influenced by the nitrate to ammonium ratios in hydroponics.

1340–1440

S06–P–61

PRODUCTION OF FUNCTIONAL KOREAN GINSENG BY SELENIUM SUPPLEMENT IN HYDROPONIC SYSTEMS

K.W. Park*, D.S. Yang

Division of Bioindustrial Science, College of Life and Environmental, Korea Univ., Seoul 136-701, Korea, Seoul, Korea, 136-701

Korean ginseng (2-year-old) was tested to demonstrate that this plant with a nutritionally important mineral (Se) is possible, making it a functional ginseng of concentrated mineral supplement, and the mineral incorporated into the enriched Korean ginseng occurs in a soluble, metabolically available form. This plant was identified that can be cultivated under hydroponic conditions to contain high level of anticarcinogenic Se compound. Sequential extraction was used to assess the degree of solubility of Se. Se content of Korean ginseng represented linear accumulation tendencies in proportion to the increase of Na_2SeO_4 concentration and duration in the nutrient solution. Result from this solubility experiment indicates that the accumulated Se element achieves very soluble form, consequently this Se-enriched plant can economically supply 100% of Se content in it to human. In addition to saponin, 2-year-old Korean ginseng containing an anticarcinogenic Se compound can be recommended as functional Korean ginseng in hydroponic systems.

1340–1440

S06–P–62

POTENTIAL OF CORIANDER AND DILL AS NEW OILSEED CROPS IN VIRGINIA

M. Rangappa*, A.A. Hamama, H.L. Bhardwaj

Box 9061, Agricultural Research Station, Virginia State Univ., Petersburg, VA 23806 USA

Coriander and dill oil are major components of world market. However, domestic production is limited and unable to meet the demand by the US chemical industry. In order to develop domestic production, characterization of variation among coriander and dill cultivars for oil characteristics is needed. To obtain such information, a replicated experiment was conducted to evaluate coriander (*Coriandrum sativum* L.) and dill (*Antheum graveolens* L.) as new oilseed crops for Virginia. Five cultivars each of coriander (Asian, C1410, C18140, Chinese, and Santo) and dill (Bouquet, Dukat, Fernleaf, Long Island Mammoth, and Tetra) were evaluated. Significant variation existed among five coriander cultivars for seed size, sugar content, and contents of 18:0, 18:1, 18:3, 20:0, and 20:1 fatty acids. The Chinese cultivar had the largest seed whereas the Asian cultivar had the smallest seeds with a mean 100-seed weight of 3 g. The five cultivars didn't differ for oil content in the seed. The average oil content was 9.5%. Significant variation also existed among five dill cultivars for protein, sugar, carbohydrate, and oil content. Bouquet had the highest values for oil content and carbohydrate content, and lowest value for protein content. Fernleaf cultivar had the lowest oil content. Results indicated that coriander and dill have potential as oilseed crops in Virginia. Research needs to be conducted to determine dual-potential of coriander and dill for foliage, harvested once or twice, and then allowing them to mature and harvest the seed for oil.

1340–1440

S06–P–63

INFLUENCE OF VARIETY AND CULTIVATION REGION OF ASPARAGUS (*ASPARAGUS OFFICINALIS* L.) ON PRIMARY AND SECONDARY PLANT COMPOUNDS

Tarek Shalaby, Silvia H Haneklaus, Christine Sator*, Ewald Schnug

Institute of Plant Nutrition and Soil Science, FAL, Bundesallee 50, Braunschweig, Lower Saxony, Germany, 38116

White asparagus (*Asparagus officinalis* L.) is an important vegetable crop in Germany, predominately grown on sandy soils. Traditional cultivation regions are among others the areas around Braunschweig (52 19.0' N; 10 29.1' E) and Erfurt (51 01.4' N; 11 02.1' E). In 2000 an extended field survey was conducted in both regions whereby geo-referenced spear and soil samples were taken. In 2001 spear, fern and soil samples of different asparagus varieties were taken from crop performance trials with new cultivars in Lower Saxony and Schleswig-Holstein. Asparagus is a medicinal plant which has a diuretic effect and is beneficial for humans with heart problems. Furthermore, the antioxidants glutathione is thought to play a role in the metabolism of xenobiotics and carcinogenics in the human body. Asparagus contains distinctly more glutathione than other vegetables and fruits with on average 26 mg/100 g. Information on genotypic and regional differences in the content of primary and secondary compounds in asparagus is limited. The aim of this study was to determine quality parameters such as the protein content, mineral composition, nitrate and glutathione content in different genotypes and the impact on the cultivation area on these parameters.

1340–1440

S06–P–64

PRODUCTION OF BIOACTIVE COMPOUNDS BY THE MEDICINAL PLANTS THROUGH TISSUE CULTURE

O.P. Saxena*[1], Himanshu Pandya[2]

[1]Botany Dept., Gujarat Universit, Navarangpura, Ahmedabad-380009, Gujarat, India; [2]Smt. D.J. Shah parivar science college, Dholka-387810. Dist. Ahmedabad, Gujarat, India

Plant tissue culture technique is being used very successfully to solve different types of problems. We have used this technique to obtain information on isolation and production of bioactive compounds (bioinsecticides, anti-tumer/anticancer compounds, alkaloids, flavanoids, steroids, etc.). Secondary metabolites are economically important besides playing important roles in the ecology and physiology of the plants. Investigations in the area of biochemical ecology indicate that some secondary compounds produced by plants are important either to protect these plants against microorganisms and animals, or to enhance the ability of one plant species to complete with other plants in a particular habitat. Despite advances in the field of organic chemistry, plants are still an important commercial source of chemical compounds having many of these secondary metabolites produced by intact plant could be synthesized by cell cultures. Alkaloids, Steroids and Flavonoids are wide spread group of natural

compounds. We have screened a larger number of plants both in vivo and in vitro (*Indigofera* sp., *Cassia* sp., *Thevetia* sp., *Catharanthus* sp., *Eclipta alba*, *Ipomea aquatica*, *Withania somnifera*, *Pongomia pinnata*, *Achryanthes aspera*, *Boerhaavia diffusa*, *Euphorbia* Sp., *Phyllanthus niruri*). We could demonstrate presence of indole compounds alkaloids, vincoside, serpentine, ajmalicine, kaemferol, quercetin, beta-sistosterol and cholesterol, etc. In case of carica papaya diosgenin was identified in callus and seeds, which in turn is a raw material for corticosteroidal hormones. It makes papaya a popular candidate, which can be employed in birth control. Another significant aspect is the identification of bioinsecticides in many *Indigofera* sp. Similarly in many of these plants listed above and screened it was evident that these were rich sources of anticancer compounds. Ayurvedic practitioners are using these plants to cure different types of cancers.

1340–1440

S06–P–65

INVESTIGATIONS TOWARDS THE PRODUCTION OF *ARNICA MONTANA* IN NEW ZEALAND

B.M. Smalfield*,[1] J.A. Douglas[2], M.H. Douglas[1], G.A. Parmenter[1]

[1]Crop & Food Research, Invermay Agriculture Centre, Private Bag 50034, Mosgiel, Otago, New Zealand; [2]Crop & Food Research Ruakura Ag. Centre Private Bag 3123 Hamilton New Zealand

Arnica montana is a potential new crop for New Zealand. Field trials were initiated to establish the environmental tolerance, adaptability and plant productivity of *Arnica* in New Zealand in a range of contrasting environments from temperate maritime to semi continental. *Arnica* has grown well and flowered successfully for past four seasons in the cool maritime environment below the 45th parallel of Southern New Zealand. The degree of winter chilling has been shown to be critical to promoting flower initiation and production of flowering stems. Day length was shown to have no effect on the initiation of flowering. Production methods are been developed. Trials have shown improved plant growth and flower production where plants were grown in raised beds compared to grown on the flat. When grown on the flat, plants were more susceptible to root rot and crown rot diseases. Plants wilted and became susceptible to disease invasion when air temperatures reached 25 to 30 °C. No significant insect pests have been identified. Weed control is important for plant survival and white clover (*Trifolium repens*) is a potential weed problem. When seedlings were propagated during the winter and transplanted into production beds in the summer a small proportion of plants flowered in the autumn but the majority of plants did not flower until the following summer. Flower production increased 5-fold from the second to the third year. The yield of dried flower ranged from 700 to 1000 kg DM/ha. Plant selection trials are currently being initiated with the aim of improving the uniformity of flowering, flower yield and levels of key target compounds. The results of this research program show that commercial arnica production is feasible and results will be presented and discussed.

1340–1440

S06–P–66

INFLUENCE OF PROPAGATION AND IRRIGATION REGIME ON THE DEVELOPMENT OF CATNIP

Aaron Hockman, Sheri M. Chavez, Ericka Aguilar, Rolston St. Hilaire*

Dept. of Agronomy and Horticulture, New Mexico State Univ., Box 30003, Las Cruces, NM 88003 USA

Demand for catnip (*Nepeta cataria* L.) as a specialty field-grown crop is increasing within the United States. Historically, the plant has been used as a cat toy filler and medicinal tea, but recent research has shown catnip was 10 times more effective at repelling mosquitoes than the compound used in most commercial bug repellents. We determined optimum propagation strategies and irrigation regimes for the production of catnip. Adventitious root formation and development were determined for terminal and single-node cuttings of catnip treated with indole-3-butyric acid (IBA) and propagated for different time intervals. Averaged over all IBA treatments, terminal cuttings propagated for 2 or 3 weeks had more dry weight (DW) allocated to shoots than roots compared to cuttings propagated for 4 weeks. Single-node cuttings had similar shoot DW and leaf area after 5, 6, or 7 weeks of growth, regardless of IBA treatment or propagation interval. Also, we determined whether irrigating plants every 2, 5, and 10 d for 12 weeks influenced physiological, anatomical, and growth traits of catnip. Plants irrigated every 10 d had the lowest root and shoot DW which averaged 142 and 19 g/plant, respectively. Plants irrigated every 10 d had the lowest leaf area (934 cm^2), while leaves watered every 5 d had the thickest leaves. In another experiment, plants were irrigated every 2, 5, and 10 d for 6 weeks. Stomatal conductance of plants irrigated every 10 days was reduced to as little as 82% of plants watered every 2 d. Biomass production was similar in plants watered every 2 or 5 d. We conclude that irrigating catnip every 10 d reduces biomass accumulation, but irrigating every 5 d might conserve water without compromising biomass production.

1340–1440

S06–P–67

INFLUENCE OF AIB AND BORIC ACID IN ROOTING OF STEM-CUTTINGS OF *ALOYSIA TRIPHYLLA* (L' HÉRIT) BRITTON

Mirian Baptista Stefanini*[1], Roseane Oliveira de Figueiredo[2], Lin Chau Ming[1], Glaucia Uesugi[1]

[1]Dept. of Plant Production-Horticulture, Agronomical Sciences College, São Paulo State Univ.-Botucatu-SP-Brazil, P.O. Box 237, Zip Code 18.603-970; [2]Dept. of Botany-Biosciences Institute, São Paulo State Univ., Botucatu-SP-Brazil, P.O. Box 510, Zip Code 18618-000

Aloysia triphylla (L'Hérit) Britton a perennial plant, arbustive, with leaves lanceolate and whorled, simple and entire originated in South America. It is used as medicinal plant in Brasil as stomatic and sedative. The employment of stem cuttings for propagation of pre-selected plants, acquires great importance, because they eliminate the juvenile phase of the plantlet, which can be produced in a smaller space of time.The rooting of stem cutting is stimulated by auxin and the boric acid supply is essential for the development of the initial rootlets and their growth. This micronutrient is requested 48 hours after plant segments had been placed in auxin solution and it can be supplied any time, including the growth period of the plantlets. The experiment was done at the Dept. of Plant Production, UNESP-Botucatu–SP-Brazil, with stem-cuttings of *Aloysia triphylla* (L'Hérit) Britton, Verbenaceae obtained from Medicinal and Aromatic Plants Garden. The aim of the work was to verify the influence of growth regulators and boric acid in stem cuttings rooting of the species. The stem cuttings with 15 cm, without leaves, were submerged during 24 h in the following solutions: water; 150 $mg \cdot L^{-1}$ of AIB; 150 $mg \cdot L^{-1}$ of AIB+ Boric acid; 250 $mg \cdot L^{-1}$ of AIB; 250 $mg \cdot L^{-1}$ of AIB + Boric acid. The statistical design was entirely randomized with 5 treatments and 3 replications, totalizing 15 parcels with 10 stem cuttings each. They were planted on propilene trays with vermiculite and maintained under nebulization during 25 days. The best results were observed with the treatment 250 $mg \cdot L^{-1}$ of AIB+ Boric acid in rooting percentage, number of roots, length of roots, dry weight of leaves and roots when compared with all other treatments. We can conclude that 250 $mg \cdot L^{-1}$ of AIB+ Boric acid should be used to obtain the highest rooting of stem cuttings of this species.

1340–1440

S06–P–68

TECHNIQUES TO IMPROVE GROWTH, MORPHOGENESIS AND SECONDARY METABOLISM RESPONSES FROM LAMIACEAE SPECIES IN VITRO

Brent Tisserat*, Steven F. Vaughn

USDA, ARS, NCAUR, Fermentation Biochemistry Tech., 1815 N. Univ. St., Peoria, IL 61604 USA

Several Lamiaceae species (e.g. basil, oregano) respond poorly to the established plant tissue culture micropropagation techniques. This study was conducted to improve growth (fresh weight) and morphogenesis (leaves, shoots and roots) responses from Lamiaceae species in vitro. Lamiaceae species were grown on various media containing several different growth regulators. In addition, different alternative novel plant tissue culture systems were also tested in order to increase biomass and shooting. A survey study with several species is presented testing a wide range of CO_2 levels. Employment of ultrahigh levels of CO_2 (i.e., 3,000 mL CO_2/L) invariably promotes higher levels of growth and morphogenesis in Lamiaceae species (e.g. basil, catnip, spearmint, others) compared to that obtained employing ambient air (350 mL CO_2/L). Employment of a sterile hydroponics system, i.e. automated plant culture system (APCS), greatly enhanced Lamiaceae species biomass and shooting over that

obtained employing an agar medium. Analysis of essential oil composition in spearmint cultures grown in various culture systems reveals that high secondary metabolite production is often associated with high growth and morphogenesis responses. This observation suggests that in vitro production of high levels of essential oils is possible. The culture systems presented in this study improves growth and morphogenesis and provides a biochemical study tool helpful in understanding how to increase secondary metabolite yields.

1340–1440

S06–P–69

INFLUENCE OF CALCIUM:NITROGEN RATIOS ON THE INHIBITION OF TUMORIGENESIS BY *SILYBUM MARIANUM* (L.) GAERTN. EXTRACTS

J. Lena Horst Warren*, Carl E. Sams

Univ. of Tennessee, Dept. of Plant Science and Landscape Systems, 369 Ellington, Plant Science Bldg. 2431 Center Dr., Knoxville, TN 37901

Silybum marianum has been extensively studied for its antioxidative and hepatoprotective properties. Additional studies have examined the anticarcinogenic activity of the flavonolignans found in the plant, with promising results. In an effort to evaluate the effectiveness of various extracts of *S. marianum* on controlling tumor development, a bioassay using potato disks inoculated with *Agrobacterium tumefaciens* to induce tumor production was performed. *Silybum marianum* was hydroponically grown in a randomized block design with nine blocks containing three fertilizer treatments which varied in Ca/N ratios (2Ca:1N, 1Ca:1N, 1Ca:2N). Seeds collected from each treatment were used in the bioassay. Total yield for each plant was also determined. Seeds were extracted using solvents of varying polarity (water, methanol, ethanol, acetone and chloroform). The extracts were dried, dissolved in DMSO and applied with the *A. tumefaciens* to the potato disks. Methanol, ethanol, acetone and chloroform extracts inhibited tumor growth by 57%, 64%, 59%, and 61% compared to controls ($P < 0.01$). The water extract was found to have no significant activity. These results are consistent with previously published data from human prostate, breast, and cervical carcinoma cell assays. Biologically active extracts had comparable inhibition to cAMP, a known anticarcinogen. Fertilizer regimes had no significant effect on the tumor suppression activity of the extracts nor were they found to effect yield (11.72 g/plant). This bioassay's consistency with other methods makes it useful for screening unknown compounds for anticarcinogenic activity.

1340–1440

S06–P–70

STUDIES ON THE CHARACTERISTICS OF CARBON AND NITROGEN NUTRITION TRANSPORTATION AND DISTRIBUTION IN GINGER

Kun Xu*, Yanyin Guo, Xiufeng Wang

Hort. College, Shandong Agr. Univ., No. 61, Daizong Street, Tai'an City, Shandong Province, China, 271018

The characteristics of transportation and distribution of ^{14}C and ^{15}N in ginger was investigated. Results shown that shoots and leaves were growth center at the seedling stage, and the 80.7% of carbon assimilates was transferred to these parts. Afterward, the distribution rate for shoots and leaves decreased gradually with the growth, whereas the distribution rate for the rhizome got higher and higher. Up to the vigorous growth stage of rhizome carbon assimilates were mainly transported from leaves into the rhizome, thus the rhizome became growth center. The absorption and utilization of nitrogen were the same as carbon assimilates. The 48.41% of nitrogen absorbed from fertilizer applied at seedling stage was distributed to the shoots and leaves. The 65.43% of nitrogen derived from fertilizer applied at vigorous growth of rhizome was 65.43% distributed into rhizomes, only 32.04% distributed into shoots and leaves. The rate of fertilizer-N utilization by ginger was quite different in different fertilizer-N applying stages. The results indicated that the rate of fertilizer-N utilization increased with the delay of application. The highest utilization rate, 45.24% was observed when fertilizer was applied at middle period of vigorous growth, while the utilization rate was only 28.09% when applied at seedling stage. The results also shown that the stored nutrients in the ginger seed were partly transferred to new plants in the whole process of growth. A certain proportion remained in the ginger seed itself. At the same time, a part of the carbon and nitrogen nutrition assimilated by the leaves and roots was transported back to seed-ginger. The exchange of carbon and nitrogen nutrition between the above ground parts and under ground seed of ginger would be the characteristics of their transportation and distribution during ginger growth. This ensured that the seed-ginger could not be shrivelled.

1340–1440

S06–P–71

STUDIES ON THE PHOTOSYNTHETIC CHARACTERISTICS OF GINGER LEAF

Kun Xu*, Yanyin Guo, Xiufeng Wang

Hort. College, Shandong Agr. Univ., No. 61, Daizong Street, Tai'an City, Shandong Province, China, 271018

Results of this experiment showed that the photosynthetic rate of 'Laiwu Big Ginger' was higher than that of 'Laiwu Small Ginger'; the photosynthetic rate of leaves at 11th–12th nodes was higher than that of the leaves at 3rd–4th nodes, and it was lowest at top leaves. The dynamic of photosynthetic rates of single leaf and canopy showed monopeak curves during the whole growth stage of ginger. The heavy midday depression of photosynthesis was observed in single leaf at both leaf vigorous growth stage and rhizome vigorous growth stages. However, no midday depression of canopy photosynthesis was noted at rhizome vigorous growth stage, maximum photosynthetic rate occurring around 13:00, but midday depression of canopy photosynthesis occurred at leaf vigorous growth stage. The results also indicated that the optimal PFD of photosynthesis for single leaf was about 1290 $\mu mol \cdot m^{-2} \cdot s^{-1}$, but 1950 $\mu mol \cdot m^{-2} \cdot s^{-1}$ for canopy. Nevertheless, CO_2 concentration for single leaves and canopy photosynthesis of ginger was similar, about 1500 $\mu L \cdot L^{-1}$. Moreover, the optimal temperature and soil water content for photosynthesis of ginger were 25%, 30%, and 75%, respectively.

1340–1440

S06–P–72

CD, PB, CU, AND ZN MAY BE ACCUMULATED IN BASIL TISSUE, BUT NOT IN THE ESSENTIAL OIL

Valtcho Zheljazkov (Jeliazkov)*, Ekaterina A. Jeliazkova

Dep. of Plant and Animal Sci, Nova Scotia Agricultural College, P.O. Box 550, Cox Build. 151-8, Truro, Nova Scotia, Canada, B2N 5E3

A two year field experiment was conducted in the vicinities of Non-Ferrous Metals Combine near Plovdiv, Bulagaria, to study the effect of both air and soil pollution on two varieties of basil (*Ocimum basilicum* L.). Plants were grown at distances of 0.5 km, 3, and 9 km from the smelter, the latter was in unpolluted area and was regarded as a control. The HNO_3 extractable concentration of heavy metals in the soils at 0.5 km was above critical values for these elements in the soil, metal concentration in the soil at 3 km was also high, while the metal concentration in the soil at 9 km from the smelter was within normal background levels. Heavy metals concentration in different plant parts and in the soil was established following NHO_3 digestion. In addition, fractionation of various heavy metals in the soil was conducted using sequential extraction procedure, and the tissue metal concentration was correlated to various forms of metals in the soils. Yields of fresh herbage and essential oil at 0.5 km from the smelter were decreased relative to the control, while yields at 3 km from the smelter were not affected. Essential oil content was not affected by the distance from the smelter, but linalool content in the oil from plants at 0.5 km from the smelter was reduced relative to the control. The other constituents of the oil varied without clear tendency. The two cultivars accumulated unequal amounts of Pb and Cd. Although tissue Cd, Pb, Cu, and Zn in plants at 0.5 km from the smelter was above their critical levels in tissue, no toxicity symptoms were observed. Essential oils from all the treatments were not contaminated with heavy metals. Therefore, basil could be grown on heavy metal polluted sites for essential oil production, without risk for contamination of the essential oil.

1340–1440

S06–P–73

AGRONOMIC AND TECHNOLOGICAL ASSESSMENT OF OREGANO (*ORIGANUM VULGARE* SPP.) BIOTYPES.

Giuseppe De Mastro*, Claudia Ruta, Vittorio Marzi

Univ. of Bari, Dipartimento di Scienze delle Produ, Vegetali–Facoltà di Agraria, Bari, Italy, via Amendola 165/a

The market interest in aromatic plants is strong, and among those in growing demand is oregano, traditionally used for the preparation of many dishes. Oregano spice, essential oil and volatile aromatic compounds are moreover employed in the food industry as spice, condiment and flavouring. There remains remarkable

confusion about the correct tassonomic identification of oregano owed to the crowd of commercialised species and this denomination continues to persist. In general, in fact, most of collected from wild population or cultivated species to produce oregano have characterized from a composition of essential oils rich in carvacrol, component to which it is probably possible attribute the characteristic taste and aroma of this spice. A part this the importance of oregano like ingredient is more and more often related to the creation of health foods due to the antioxidant capacities of its compounds. In the present research the results on morphological, chemical and agronomic characteristics about some clones obtained by spontaneous material in different environments of south Italy was reported, in order to better characterize and appreciate their, according to the actual and new possible utilization.

1340–1440

S06–P–74

JERUSALEM ARTICHOKE (*HELIANTHUS TUBEROSUS* L.) AND CHICORY (*CICHORIUM INTYBUS* L.): POTENTIAL CROPS FOR INULIN PRODUCTION IN THE MEDITERRANEAN AREA

Giuseppe De Mastro*, Giovanni Manolio, Vittorio Marzi

Univ. of Bari, Dipartimento di Scienze delle Produ, Vegetali–Facoltà di Agraria,Italy, via Amendola 165/a

Chicory and Jerusalem artichoke are among the best crops for inulin production; for this reason they are the crops toward which the research interest are mainly oriented. Inulin and other polyfructosides are used in many applications: mainly for the production of high-fructose syrups, other food applications, and for the production of ethanol and in the nonfood industry. Results are reported of field trials on chicory and Jerusalem artichoke conducted, over a 2-year period (1999–2000) in south Italy at Monopoli (40 57' N, 17 15' E, 12 m a.s.l), typical of the Mediterranean area by the frame work of the research project "Crops for inulin production: modelling of the environmental effects and cropping strategies", granted by the Italian Ministry of Univ. Scientific and Technological Research (MURST). The aims of the study was to determine the biomass and carbohydrates dynamics of the plants and define the define growing techniques suitable for the highest inulin production. Main agronomic factors (irrigation and time of harvest) were investigated. The yield potential of the crops were influenced by the growing techniques tested with promising results especially in terms of the inulin quality.

1340–1440

S06–P–75

COLOURED POLYETHYLENE MULCH AND PLANT DENSITY IN GROWING SWEET BASIL (*OCIMUM BASILICUM* L.)

Ivanka Zutic, Gordana Stanic, Nikola Blazevic, Josip Borosic

Svetosimunska c. 25, 10000 Zagreb, Croatia, Zagreb, Croatia, 10000

Mulch of tinted polyethylene (PE) films influence physical and chemical characteristics of the soil, leading to changes in plant growth and development, and influencing agronomic traits of cultivated plants. The same traits are influenced also by various plant densities. The aim of the research is to determine the effect of mentioned factors upon yield components of sweet basil (cv. Genovese) in the open field production. The research carried out during the years 2000 and 2001 includes two field trials. Opaque, differently coloured PE films (black, white-black, brown and yellow-brown) and semitransparent grey film were used as mulch and compared with bare soil, with plant density of 24 plants per square meter. In the second trial four plant densities (24, 40, 60 and 80 plants per square meter) were researched, along with mulch of black PE film. Essential oil was hydrodistilled using a Clevenger apparatus, and its components were analysed by the GC–MS method. Meteorological conditions in the year 2000 allowed for four fresh herbage harvests, and in 2001 only two or three. Average soil temperatures at a depth of 10 cm at 8 AM and 2 PM were higher under mulch of opaque PE films than on bare soil. In the year with hot summer, the highest yields of fresh herbage were obtained from plots with opaque PE mulch and with plant densities of 40 to 80 plants per square meter, however, essential oil yields were higher only on plots with brown and yellow-brown mulch. In the conditions of cool summer, the highest yields were obtained only by black mulch and plant density of 80 plants per square meter. The treatments did not affect the content of the main essential oil components linalool and methyl chavicol.

1340–1440

S06–P–76

MASS PROPAGATION OF MEDICINAL PLANTS THROUGH TISSUE CULTURE TECHNIQUE FOR SUSTAINABLE USES AND SALEABLE PRODUCTION

S.K. Roy*, M.R. Karim, M.S. Hassan, P. Sinha

Dept. of Botany, Jahangirnagar Univ., Savar, Dhaka, Bangladesh, 1342

Medicinal plants, which are non-wood forest products, have played a very important role from time immemorial among the illiterates and the highly civilized persons in healing diseases. Medicinal plants are still widely used by men and women of the east and the west not to speak of tribals. Recent developments in plant chemistry and pharmacology have lead to an increased interest in the utilization of the products of medicinal plants. In Bangladesh there is an increasing trend of utilization and industrial use of medicinal plants. At present there are many Ayurvedic and Unani manufacturing firms in Bangladesh. These manufacturing firms exploit the medicinal plants indiscriminately for their raw materials. So it has become imperative that the exploitation of medicinal plants must be accompanied by cultivation in the forests. We utilized biotechnological methods for mass propagation and cultivation of three highly endangered medicinal plants, *Rauvolfia serpentina*, *Gloriosa superba* and *Smilax macrophylla* as a model for their sustainable industrial uses, saleable production and their ex situ and in situ conservation as well. The methodology is detailed in this paper which includes 1) Initiation of aseptic culture, 2) Multiplication of shoots, 3) Rooting, 4) Acclimatization, 5) Transplantation and 6) Evaluation of crop yield after three of transplantation.

1340–1440

S06–P–77

INFLUENCE OF DIFFERENT LEVELS OF NITROGEN AND POTASSIUM ON GROWTH AND YEILD OF TURMERIC

Annie Thoma*, D.B. Singh

[1]38/4 ITI Colony, Naini, Allahabad, Uttar Pradesh, India, 211010

A field experiment was conducted on the Horticulture Research Farm of Allahabad Agriculture Institute (Deemed Univ.) with a view to study the "Influence of different levels of Nitrogen and Potassium on growth and yield of turmeric (*Curcuma longa* L.) cv. Suvarna" during kharif season of 2000. The experiment was laid out in 3 x 3 factorial arrangement in randomized block design (RBD) with three replications. The factors where N (nitrogen) and K (potassium) with three levels each, with the spacing of 50 x 50 cm. The influence of different levels of Nitrogen and Potassium was found to be effective in increasing the growth and yield parameters like plant height, number of leaves, leaf area, number of tillers, length and girth of mother rhizome, fresh weight, curing percentage and rhizome yield .Thus on the basis of investigation it could be concluded that growth and yield potential of crop under Allahabad Agro climatic condition can be increased by applying NPK at the rate of 75:60:150 kg/ha.

1340–1440

S06–P–78

MEDICINAL AND AROMATIC PLANTS IN ITALY: SITUATION AND PERSPECTIVE FOR THE PIEDMONT REGION

Silvana Nicola*, Jeanet Hoeberechts, Emanuela Fontana

Dipartimento di Agronomia, Selvicol, Univ. of Turin, Via Leonardo da Vinci, 44, Grugliasco, TO, Italy, 10095

This abstract presents the results of the first year of activity of a 3-year project on Medicinal and Aromatic Plants (MAPs) in Piedmont, Italy (45 North). Cultivation of MAPs in Italy has a long tradition. The last available data indicate that in Italy there are about 2500 ha cultivated, of which half are cultivated with herbaceous species. The Piedmont Region plays a key role having about 570 ha of herbaceous species. Recently, there has been a growing interest on the opportunities and potentialities to increase the cultivation of MAPs. This is particularly true for the areas, which are either marginal or abandoned by inhabitants that moved to live in the big cities and suburbs. In fact, the cultivation of MAPs could contribute to increase the low farm income, typical of these zones. In addition, there is a new approach toward the coming back of people to rural areas, especially related to organic farming system. Lastly, there is a growing interest among localities to increase agricultural activities that relate to social and environmental

aspects, such as culture, tourism and education, throughout the promotion of the activities that enhance the restoration and conservation of the agricultural land and of the environment. The Univ. of Torino has been funded by the Regional government to investigate, collect information, analyse data and draw up a map of the impact in the region of the MAP cultivation. Agronomical needs of MAPs will be correlated, with pedological and meteorological data on one hand, with social and economical data on the other hand, to better describe the actual situation and offer technical support for regional policy makers. The results from the project are also intended to offer solutions to implement cost effective key actions for land management in marginal areas. The results for the first year of the project are presented, with the data from the survey in the Region regarding the major areas involved in MAP cultivation.

1340–1440

S06–P–79

REDUCED INPUT PRODUCTION OF HERBS UNDER SUB-TROPICAL CONDITIONS IN FLORIDA

Alexander A. Csizinszky*

Univ. of Florida, Gulf Coast Research and Education, 5007 60th St. East, Bradenton, FL 34203 USA

Climatic conditions in west-central Florida (lat. 27 N, long. 82 W) are favorable for herb production from fall through winter and spring. This period coincides with the greatest demand for herbs, especially organically produced herbs in the United States. Studies were initiated therefore to investigate optimum planting time and compost rates of 0, 4.5, 9.0, and 18.0 $t \cdot ha^{-1}$, with or without added N and K fertilizers, for herbs in multiple harvests. Production system was the full-bed polyethylene mulch with micro- (trickle-) irrigation. Pesticides were not applied for the herbs. Fresh weight yields of marjoram (*Origanum majoranna*), Italian parsley (*Petroselinum crispum* var. *neapolitanum*), and thyme (*Thymus vulgaris*) were higher when planted in December or January than in October or March. Yields of marjoram and thyme in the first two to three harvests were similar 9.0 $t \cdot ha^{-1}$ compost and no added N and K fertilizers to yields with N and K fertilizers with or without compost. Italian parsley yields were higher with compost plus added N and K fertilizers than with compost alone. Disease was not apparent on the plants but aphids (Aphididae) were found on parsley and whiteflies were numerous on marjoram. Root knot nematodes (*Meloidogyne* sp.) were detected on Italian parsley roots at the end of the season.

1340–1440

S06–P–80

STRATIFICATION AND PRIMING MAY IMPROVE SEED GERMINATION OF PURPLE CONEFLOWER, BLUE-FLAG IRIS, AND EVENING PRIMROSE

David Wees*

Macdonald Campus McGill Univ., 21,111 Lakeshore Road, Sainte-Anne de Bellevue, QC, Canada, H9X 3V9

Several North American native wildflowers have potential for medicinal use and ornamental horticulture; however the seeds of some species have poor, erratic or slow germination. The goal of this project was to improve germination, using stratification or priming (osmoconditioning), of the seeds of purple coneflower (*Echinacea purpurea*), narrow-leaf purple coneflower (*E. angustifolia*), blue-flag iris (*Iris versicolor*) and evening primrose (*Oenothera biennis*). Stratification consisted of storing seeds in wet paper towels at 4–5 °C for 4 weeks (in 1997) or 3 weeks (in 1999). Priming consisted of soaking seeds in an aerated 0.1 M or 0.2 M solution of KNO_3 for 7 days in 1999; in 1997 a 0.1 M solution was used for 5 days. Both stratification and priming improved germination percentage of *E. purpurea* from 44% to 83% and 69% respectively; these treatments also reduced the time to germination from 13 days to 8 or 6 days, respectively. With *E. angustifolia* stratification, priming and the control gave respectively 22%, 24% and 12% germination in 1997; germination was much poorer in 1999 and never exceeded 10%; in 1997, primed seeds germinated in 7 days compared to 10 days with stratification and 14 days with the control. With *I. versicolor* stratification, priming and the control gave respectively 58%, 33% and 9% germination in 1997 and 17%, 1% and 0% in 1999; germination was very slow and took 24 to 34 days in 1997 and 12 to 19 days in 1999. Germination of *O. biennis* was slightly improved by stratification (71% germination) or priming (68%–74%) compared to the control (67%); stratification and priming reduced time to germinate by 1–2 days.

1340–1440

S06–P–81

IN VITRO SHOOT MULTIPLICATION OF *ECHINACEA PURPUREA*

C. Park[1], Adolfina Koroch*[1], J. Kapteyn[2], H. Juliani[1], J. Simon[1]

[1]New Use Agriculture and Natural Plant Products, Program, Rugers Univ., Foran Hall, New Brunswick, NJ 08901 USA; [2]Dept. of Horticulture and Landscape Architecture, Purdue Univ., West Lafayette, IN 47907 USA

The genus *Echinacea* (purple coneflower), represented by eleven taxa found in the United States and in south central Canada, has been described as the most important plants used by the native Americans for treatment of many diseases. *Echinacea* has received considerable attention in recent years for its medicinal qualities and ornamental value. The objective of this study was to develop a method for rapid in vitro shoot multiplication from *Echinacea purpurea*. Shoots were obtained by placing leaf explants on Murashige and Skoog (MS) media containing myo-inositol (100 $mg \cdot L^{-1}$), thiamine (0.4 $mg \cdot L^{-1}$), and sucrose (2% w/v) and supplemented with BAP (4.44 µM) and NAA (0.054 µM). Shoots obtained after a 5-week culture period were used to initiate micropropagation. Multiplication was performed on the same basal media supplemented with different concentrations of 6-benzylaminopurine (BAP), kinetin (KIN) and isopentenyladenine (2iP) alone or in combination with naphthaleneacetic acid (NAA). Shoot multiplication of *E. purpurea* was achieved through axillary bud proliferation as a result of varying the balance of auxin to cytokinin. Proliferating shoot culture were obtained on MS media supplemented with different cytokinines alone or in several combinations with NAA. The highest number of adventitious shoots was observed on MS media supplemented with 17.76 µM BA and 0.269 µM NAA. Kinetin was less efficient than BAP in promoting shoot multiplication, and the lowest rate of multiplication was obtained in media supplemented with 2iP. The combination of BAP and NAA was the determining factor of shoot proliferation, increasing the concentration of NAA promote shoot proliferation. Development of a rapid multiplication system will facilitate the development of ornamental and medicinal genotypes by permitting the rapid clonal multiplication of large numbers of plants from a single elite parental selection. This shoot multiplication method will provide an efficient means of rapid shoot multiplication of a single specific genotype obtained after a relatively low efficiency regeneration event as in the case of *Agrobacterium* transformation and subsequent regeneration on selective media.

1340–1440

S06–P–82

INDIGENOUS PARAQUAT RESISTANCE OF KOREAN FOXGLOVE (*REHMANNIA GLUTINOSA* LIBOSCH.) AND ITS IN VIVO MULTIPLE ADVENTITIOUIS BUDS FORMATION

Chung Heon Park*[1,2], Nak Sul Seong[2], James E. Simon[1]

[1]New Use Agriculture and Natural Plant Products Program, Rugers Univ., Foran Hall, New Brunswick, NJ 08901 USA; [2]National Crop Experiment Station, Rural Development Administration, Suwon, Kyunggi 441-100, Republic of Korea

Korean Foxglove (*Renmannia glutinosa* Libosch.), member of the Scrophulariaceae family, is used in a wide number of for crude drug applications in Korea, China and Japan. There are three types of *Rehmannia* spp. traditionally used in oriental medicine. One is *Rehmannia glutinosa* native to Korea; *R. glutinosa* var *hueichingensis* native to China; and *R. glutinosa* indigenous to Japan. The Chinese species typically has a single large and thick root; the Japanese type is very thin and long; and Korean foxglove could be characterized as intermediate between the others. Korean foxglove is used three ways in traditional medicine; as a fresh root; or dried in a poison antidote preparation, to stop bleeding and bruises. This medicinal is also traditionally used in the treatment of blood, healthy, diabetes and hypertension. As Korean foxglove is so popular, growers cultivating this crop observed that weed control is difficult and use paraquat to reduce weed pressure. A Korean farmer observed that a Korean foxglove survived repeated applications of paraquat. Those plants were then collected and we set out to reconfirm that field observation by subjecting the cloned plant materials to paraquat application treatments using two kinds of *Rehmannia* spp. Following herbicide application and a water control spray, plants were observed to foliar damage, and monitored for the length of time required to recover. Korean foxglove plants had a much higher survival rate 40 days post application than Chinese material (83.5% vs. 58.3%, respectively). There were NSD in root growth across the different concentrations of

paraquat applications with the Korean foxglove, but the Chinese foxglove exhibited decreased root growth compared to control. During the harvest time, we found that the paraquat treatments appeared to induce multiple adventitious shoot formation in only the Korean foxglove. In vivo multiple adventitious shoot formation was induced more than 4%X above the control from paraquat application and reached as high as 20% higher than the controls from the highest herbicide application rate.

1340–1440
S06–P–83
A UNIVERSITY EDUCATION AND OUTREACH PROGRAM FOR MEDICINAL AND AROMATIC PLANTS

Zoë Gardner*, Lyle E. Craker

Dept. of Plant and Soil Sciences, Univ. of Massachusetts, Amherst, MA 01003 USA

Medicinal and aromatic plants represent a relatively new area of horticultural education with considerable student and grower interest. To meet the demand for classes and information, the Univ. of Massachusetts has developed a series of horticultural classes and outreach efforts to support current and future farmers and research scientists in this area. Emphasis has been focused on establishing a fundamental understanding of the myth, tradition, and science that envelops medicinal and aromatic plant materials and building foundations in horticulture, ethnobotany, chemistry, plant identification, and applications related to medicinal and aromatic plants. An annual, student sponsored HerbFest is held on campus to develop student and public interest in medicinal and aromatic plants and plant products. Outreach activities at the Univ. include providing grower information, writing and editing books, publishing journals, teaching evening classes, and working with elementary and secondary school children.

1440–1500
S06–O–84
RELATIONSHIP BETWEEN UNDERSTORY LIGHT AND ROOT GINSENOSIDE CONCENTRATION OF AMERICAN GINSENG (*PANAX QUINQUEFOLIUS* L.) CULTIVATED IN A BROADLEAF FOREST

A.R. Fournier[1], J.T.A. Proctor[2], A. Gosselin[1], S. Khanizadeh[3], A. Bélanger[1], M. Dorais*[1]

[1]Agriculture and Agri-Food Canada, Horticultural Research Centre, Envirotron Bldg., Laval Univ., Ste-Foy, Quebec, Canada, G1K 7P4; [2]Dept. Horticultural Science, Univ. of Guelph, Guelph, ON, Canada, N1G 2W1; [3]Horticultural Research and Development Centre, Agriculture and Agri-Food Canada, 430 Blvd Gouin, St-Jean-Richelieu, QC, Canada, J3B 3E6

Given the economic importance of ginsenosides as highly esteemed medicinal compounds, knowledge of the environmental factors that control ginsenoside accumulation in ginseng plants is of great commercial importance. Exposing ginseng plants to high light intensities has proved to be an effective method to maximise the ginsenoside concentration in Asian ginseng roots grown under artificial shade. However, few works have studied the relationship between the light levels in natural conditions and the ginsenoside concentration in ginseng roots. Growing in its natural habitat, American ginseng is exposed to dramatic changes in light intensity and light quality during canopy deployment. The objective of this study was to determine the relationship between the light conditions residing in a beech-dominated forest and the accumulation of six ginsenosides (Rg1, Re, Rb1, Rc, Rb2, and Rd) in 1- and 2-year-old American ginseng roots. Hemispherical photography and spectroradiometry were used to quantify the understory light conditions. One-year-old root samples were collected in September 1999, while 2-year-old root samples were amassed in July and September 2000, and subsequently analysed using HPLC to determine their ginsenoside concentrations. Our results revealed that the ginsenoside concentration in the 1- and 2-year-old roots collected in September was significantly related to amount of direct and total light and the duration of sunflecks. At this time, the 1- and 2-year-old ginseng plants exposed to the highest light levels contained 32% and 51% more ginsenosides in their roots than the plants grown under the lowest light levels. Furthermore, understory light quality had significant effects on certain individual ginsenoside concentrations in the 2-year-old roots collected in mid-season. Our results also showed that the American ginseng roots contained higher ginsenoside concentrations than roots cultivated in artificial shade and even in wild roots.

1500–1520
S06–O–85
MASS PROPAGATION OF *ECHINACEA ANGUSTIFOLIA* USING SYNTHETIC SEED TECHNOLOGY AND A TEMPORARY IMMERSION BIOREACTOR

H. Lata*, E. Bedir, I. Khan, R.M. Moraes

NCNPR, School of Pharmacy, The Univ. of Mississippi, Univ., MS 38677 USA

Echinacea is one of the best selling medicinal herbs in the world. It has received considerable attention in recent years due to high medicinal qualities in preparation for treatment of cold and as immunostimulant and antiinflammatory remedy. This popularity has led to need for improvement in propagation for faster multiplication and rapid availability of elite clonal selection. Clonal micropropagation of *E. angustifolia* accession PI 312814 provided by the National Germplasm Bank (USDA) through the National Genetic Resource Program, has been successfully achieved using hypocotyls as the explants. A total of 74 clones were obtained in MS half strength salt medium supplemented with 0.5 mg/L and subcultured every 20 days. These clones were also analysed using echinacoside, cichoric and chlorogenic acid and have revealed tremendous chemical variation. As in vitro propagation allows for selection and clonal multiplication of genetically superior clones, we have used novel systems such as 1-l temporary immersion bioreactor (RITA) and synthetic seed technology for our studies. Increase in number of shoots was obtained within 20 days of culture. The synthetic seeds provide a potential method to combine the advantages of clonal propagation with the low cost and high volume capabilities of mass propagation. Till date, there are no reports or very low rooting of *E. angustifolia*. By using this technology we have got 75% rooting in the cultures. Shoot buds of *E. angustifolia* were encapsulated in sodium alginate to produce individual beads. The encapsulated beads when cultured on MS medium supplemented with 0.5 NAA. The rooting response is seen in three weeks. This technique provides an easy and novel propagation system for elite as well as difficult-to-root species of *Echinacea*.

1520–1540
S06–O–85–A
TO BE ANNOUNCED

1540–1600
S06–O–86
ABOUT SOME FACTORS LIMITING CULTIVATION OF MEDICINAL PLANTS

Oiga Chervyakova*, Marina Keldish

Main Botanical Garden RAS, Main Botanical Garden RAS, Main Botanical Garden RAS, Moscow, Moscow, Russia, 127276

The viruses and mycoplasmas are one of the important factors limiting cultivation of medicinal plants and worsening quality of raw material for production of medical drugs. Among planting in territory of Russia and countries of CIS of simples the important place is occupied by the representatives of family Solanacea, which cultivated in industrial conditions for reception alkaloids (*Solanum laciniatum* Ait., *Atropa belladonna* L., *Hyoscyamus niger* L., *Datura stramonium* L. and *D. innoxia* Mill.). To most widespread on these kinds of plants pathogenic the viruses Tobacco mosaic virus (TMV), Potato virus Y (PVY) and Potato virus X (PVX), Arabis mosaic virus (ArMV) and Bean yellow mosaic virus concern which cause dangerous diseases. On kinds *Scopolia* two diseases are revealed. One of them—leaf curl, is caused bacilliform virus from group Rabdo. The second disease described bushy dwarf and green petal, is caused mycoplasmas. On kinds *Plantago*, including on wide cultivated *P. major* L. also detected TMV, PVX, PVY and Tomato ringspot virus. On *Mentha piperpita* L., which also concerns to industrial cultures the wide spectrum of symptoms associated with TMV, Tobacco rattle virus and Cucumber mosaic virus (CMV) is revealed. We register also viruses and on other medicinal cultures: *Primula officinalis* L. and *Digitalis grandiflora* Mill.–CMV; on *Salvia officinalis* L.–Tobacco ringspot virus; on *Lappa* sp.–Strawberry latent ringspot virus and Carnation mottle virus. A lot of virus diseases with a wide spectrum of external attributes are revealed on species and sort of *Sorbus*, and also on *Padus*. During identification fixed, that their agents concern to various taxonomical to groups, however prevail ILAR and NEPO viruses (*Prunus* necrotic ringspot virus, ArMV, Raspberry ringspot virus), which, as a rule, meet in com-

position of a complex infection. Investigated cultures the unusual viruses, from Poty, Tobamo, Carla and Potex of groups are also revealed.

1600–1620
S06–O–87
PERSPECTIVES OF THE MARKET OF MEDICINAL AND AROMATIC PLANTS IN ITALY

Alessandra Castellini*, Carlo Pirazzoli

Dept. of Agr. Eng. and Economics, Univ. of Bologna, Via Fanin, 50, BOLOGNA, ITALY, 40127

During last decade the Italian surface dedicated to medicinal and aromatic plants cultivation has increased more than 50%, pushed by a rising market success. Consumers, preferring natural substances to chemical ones, have shown a great interest for the products deriving from those plants. At the same time, the Italian turnover from herbals retail sales has reached 800 million dollars, placing itself at the third position in Europe, after Germany and France, and, in the opinion of some researchers, it could peak 1 billion dollars in 2002. Italy, with a "self-provision" rate of about 25%–28%, needs a great import of raw and half-manufactured materials, reaching in the latest years a value around 420 million dollars for satisfying the manufacturing demand. The main processing lines, which exploit more than 60% of the available supply, are related to the preparation of therapeutic products from vegetable ingredients and to the food industry. It's estimated that the market of phyto-medicinals in Italy has an average yearly increase of about 10%. The cultivation of medicinal and aromatic plants in Italy is characterised by high quality products, often obtained through organic methods, but the average price is rather high and this decreases its competitiveness. The adoption of cultivation technics with a low environmental impact allows for a wide diffusion of this species in marginal areas suffering from a depopulation risk. The most used retail sale channels for herbal products in Italy are the erboristerie (herbal shops) which in the latest years have increased considerably, reaching almost the number of 4,600 units, widespread in all the peninsula. Considering that situation, the aim of this paper is to evaluate the possibilities of development in Italy of these plants, both from the agronomic and from the socioeconomic point of view, in order to show the most suitable areas and the possible gaps to fill in for an organised evolution of the sector.

1620–1640
S06–O–87–A
TO BE ANNOUNCED

1640–1700
S06–O–87–B
TO BE ANNOUNCED

Friday · August 16

0800–0900
S06–P–88
BIOFLAVONOID PROFILE IN EXOTIC CITRUS SPECIES

Maria Botero Omary*[1], Robert R. Krueger[2], Yingqin Li[1], Puri David[1]

[1]Nutrilite, Division of ABG, 19600 6th Street, Lakeview, CA 92567-8403 USA; [2]USDA-ARS National Clonal Germplasm Repository for Citrus and Dates 1060 Martin Luther King Blvd., Riverside, CA 92507-5437 USA

The levels of the flavanones naringin, hesperidin, narirutin, eriocitrin, neohesperidin and neoeriocitrin, the flavone diosmin and the polymethoxylated flavone tangeretin were evaluated in fruits of several exotic citrus (citron, pummelo, sour orange, papeda, mandarin, and lemon). Samples were collected at the USDA-ARS National Clonal Germplasm Repository for Citrus and Dates (Riverside, CA). Analyses were conducted using high-pressure liquid chromatography. The highest total flavonoid content was detected in sour oranges, mandarins and pummelos, while low to non-detectable levels were found in citron, papeda and lemon cultivars. Average total bioflavonoid values on a dry weight basis were 4.5%, 4.5% and 2.3% in sour oranges, mandarins and pummelos, respectively. Individual flavonoids varied among species. Naringin, neohesperidin, and neoeriocitrin were found in some sour orange cultivars. Hesperidin was the only flavonoid detected in mandarin. Pummelos showed a diverse flavonoid profile. Some pummelo varieties had up to 6 different flavonoids (narirutin, naringin, hesperidin, eriocitrin, neohesperidin and neoeriocitrin). Citrus flavonoids have a wide variety of clinical applications. This information should prove useful to the nutraceutical industry in identifying alternative sources of flavonoids.

0800–0900
S06–P–89
IMPROVEMENT OF ARTEMISININ PRODUCTION OF *ATEMISIA ANNUA* USING GAMMA IRRADIATION

C. Kirdmanee*, A. Chochai, P. Wanichananan, S. Kamchonwongpaisan

National Center for Genetic, Engineering and Biotechnology, 73/1 Rama VI Road, Rajdhevee, Bangkok, Thailand, 10400

Artemisinin is a potent antimalarial produced by the Chinese medicinal herb called "qinghao" (*Artemisia annua*). However, the *A. annua* grown in the tropical area produced the low artemisinin production. The objective of this investigation was to increase the genetic variation affected on artemisinin production of *A. annua* using the gamma irradiation. Elite clone of *A. annua* was multiplied in-vitro on Murashige and Skoog (MS, 1962) medium. One thousand shoots were treated by gamma irradiation at 200, 500, 800 and 1,100 rad and subcultured every month for 3 months. The survival percentage was estimated. The LD50 was found in the shoots treated by gamma irradiation at 800 rad. The shoots treated by gamma irradiation at 0 (control) and 800 (mutation) rad were cultured photoautotrophically on MS sugar-free medium at 23–25 and 30–32 °C air temperature for 1 month and transferred to ex vitro. These plants were grown at 30–38/26–29 °C air temperature (day/night) in the field at Kanjanaburi, Thailand. Forty-six percent of mutation lines produced the higher artemisinin than control line. There are three mutation lines cultured in vitro at 30–32 °C air temperature shown higher artemisinin production and antimalarial activity than those cultured in vitro at 23–25 C. The artemisinin productions of these three mutation lines cultured in vitro at 30–32 °C air temperature were higher triple when compared with those of control line. The artemisinin production and antimalarial activity of these three mutation lines grown in the field were 1.8–2.3% and <0.01 μg/mL, respectively.

0800–0900
S06–P–90
ARTEMISININ PRODUCTION OF *ARTEMISIA ANNUA* PLANTLETS UNDER PHOTOAUTOTROPIC CONDITIONS

C. Kirdmanee*, S. Kamchonwongpaisan

National Center for Genetic, Engineering and Biotechnology, 73/1 Rama VI Road, Rajdhevee, Bangkok, Thailand, 10400

Artemisia annua shoots (initial length: 2.1–2.5 cm) were cultured in vitro on the Murashige and Skoog (MS, 1962) medium supplemented with 0.00 (photoautotrophic condition) and 81.64 (photomixotrophic condition) mM sucrose under carbondioxide enrichment (1,000–1100 μmol/mol) and carbondioxide non-enrichment (350–400 μmol/mol) conditions at 23–25 °C air temperature and 75–85 $\mu mol/m^{-2}/s^{-1}$ photosynthetic photon flux density for 5 weeks. Growth (dry weight and leaf area), antimalarial activity and artemisinin production were measured. The growth of the plantlets cultured under photoautotrophic condition was higher than those of the plantlets cultured under photomixotrophic condition. Carbon dioxide enrichment significantly increased the growth and antimalarial activity of plantlets regardless of the concentration of sucrose. The greatest growth, the highest antimalarial activity and the highest artemisinin production were observed in the plantlets cultured photoautotrophically under carbondioxide enrichment condition. The artemisinin production of the plantlets cultured under photoautotrophic condition was higher almost twice than those of the plantlets cultured under photomixotrophic condition. Results indicated that photoautotrophic condition promoted not only the growth but also the secondary metabolite production of plantlets in vitro.

0800–0900
S06–P–91
COMPARATIVE STUDY ON THE BIOACTIVE COMPONENTS AND ELEMENTS OF SOME *SALVIA* SPECIES

K. Szentmihályi*[1], M. Then,[2] C. Csedo[3]

[1]Chemical Research Center, Hungarian Academy of Sciences, Budapest, 1525 P.O. Box 17. Hungary; [2]Semmelweis Univ., Faculty of Pharmacy, Dept. of Pharmacognosy, 1085 Budapest, Üllöi street 26, Hungary; [3]Univ. of Medicine, Dept. of Pharmacognosy, Tirgu Mures, Romania

The dried leaves of *Salvia officinalis* L. are highly popular medicinal drug in Hungary. The plant is cultivated in central Europe similarly to *S. sclarea* L. Several sages grow wild as furrow-weeds and one species is known as a protected plant. *Salvia officinalis* L., *S. sclarea* L., *S. pratensis* L. and *S. nemorosa* L. originated from Hungary and Transylvania were investigated. Morphological comparison of fruit surface and covering hair was made with scanning electron microscopy for the four species. The sage fruits specifically differ in size, shape and surface structure. Trichomas of sages also differ in shape and extent. A qualitative comparative study was performed for terpenes from volatile oils by capillaric gas chromatography. Borneol and a-thujone were detected in each sage species whereas in three sage species linalyl acetate, a-pinene and b-pinene were found to be present as well. Element concentration of samples was determined by inductively coupled plasma atomic emission spectrometry (ICP–AES) for the following elements: Al, B, Ca, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, P, S, Zn. The element concentrations differ significantly between the species and within one species greatly depend on the place of collection. The common feature of the species seems to be the relatively high chromium content.

0800–0900

S06–P–92

BIO-MORPHOLOGICAL AND CHEMICAL CHARACTERIZATION OF ROSEMARY (*ROSMARINUS OFFICINALIS* L.) BIOTYPES

G. De Mastro*[1], A. Mincione[2], M. Poiana[2], C. Ruta[1]

[1]Univ. of Bari, Dipartimento di Scienze delle Produ, Vegetali–Facoltà di Agraria, Bari, Italy, via Amendola 165/a; [2]Istituto di Microbiologia e Tecnologia Agraria e Forestale Università degli Studi Mediterranea di Reggio Calabria–Reggio Calabria, Italy

The use of herbs in the food industry has recently increased notably because of their antioxidant action on lipid degradation, apart from their traditional role in food aroma. In particular, rosemary (*Rosmarinus officinalis* L.) extracts proved to possess such useful antioxidant proprieties. In the present research the result of a morphological and chemical characteristics study conducted on rosemary clones obtained by spontaneous material collected in different environments of southern Italy is reported, with the aim to characterize and evaluate better their potential for present and possible new food technological utilization. In addition to morphological characterizations aimed to discern differences among clones, from a technological point of view was carried out a qualitative oil component "fingerprint" by means of GC–MS, comparing also two different extraction techniques of the essential oil fraction (traditional water steam distillation and dichlorometane solvent extraction) as for quantitative and qualitative differences.

0800–0900

S06–P–93

MORPHOLOGICAL STUDY IN THREE VARIETIES OF *ROSA DAMACENA* AND IDENTIFICATION OF THEIR ESSENTIAL OIL

M. Mahdavian*, M. Mirza, F. Fallahi

Dept. of Horticulture, Agriculture Faculty, Tehran Univ., Karaj, Tehran, Iran, 31587-11167

Study about physiochemical characterizations in local verities of *R. damscena* was the focus of this research. *Rosa damascena*, is one of the most important species of *Rosa*. In respect of flower oil production and its cultivation has a long history in ghamsar of Kashan, which is located in center of Iran. There have been known three local varieties including 'Azaran', local 'Ghamsar' and 'Azvar' in this site. It is supposed that each one of these three species has their special characteristics. Which differentiated it from another and from all other oil producing cultivars. Study about oil constituents of these three variety by using GC–mass approach and comparing resulted data with existing information about other modern economic cultivars and species help us clarify important points about quality and quantity values of these land varieties. Furthermore these information could been used by breeders in order to producing new and suitable variety. In the point of morphological characters a comparison took place between vegetative and productive organs such as stems, leaves, flowers, etc. Little differences were shown.

0800–0900

S06–P–94

VARIATION IN MORPHOLOGICAL AND BIOCHEMICAL CHARACTERS IN GENOTYPES OF MACA AND YACON

A. Lebeda*, I. Dolezalov, K. Dolezal

Palack? Univ. at Olomouc, Dept. of Botany, älechtitelu 11, Olomouc-Holice, Czech Republic, 783 71

Maca (*Lepidium meyenii* Walp.) and yacon (*Smallanthus sonchifolius* (Poepp. & Endl.) H. Robins.)) have been little known and neglected in Europe in contrast to potatoes and maize originating from the same Andean region. The potential value of maca and yacon has been reevaluated because of antidiabetic, nutritious and fertility-enhancing properties of both crops. The cultivation of maca and yacon in the Czech Republic was first reported in the 1990. A set of 14 genotypes of maca and 25 genotypes of yacon were studied for morphological and biochemical variability, differences in developmental stages and the occurrence of diseases and pests. Plants were cultivated and evaluated under field conditions (altitude ca 210 m, day mean temperature 16.3 °C, precipitation during cultivation period 271.4 mm) from May to October 2001. Morphological description was focused on seedling leaves, rosette and cauline leaves; shape, skin surface and colour of tuberous roots, inflorescences and fruits. The preliminary data showed different levels of expression for these characters among individual genotypes. Isozymes polymorphism of esterases and acid phosphatases was also used for characterization of the maca and yacon genotypes. No variation in acid phosphatase isozymes was recorded in either species. However, for esterase zymograms variation was found with three groups in maca and four groups in yacon. The biochemical analyses of dietetic features of tuberous roots are in progress.

0800–0900

S06–P–95

CLONING AND CHARACTERIZATION OF PROTOCATECHUALDEHYDE METHY TRANSFERASE FROM VANILLA CULTURE

Fulya Eren Pak[1], Daphna Havkin-Frenkel*[2], Galina Kourteva[1], Faith Belanger[1]

[1]Biotech Center, Rutgers the State Univ. of New Jersey, New Brunswick, NJ USA; [2]David Michael and Co. Philadelphia PA USA

Vanillin is a commercially important flavor compound isolated from the plant *Vanilla planifolia*. Protocatechualdehyde 3-O-methyltransferase (POMT) catalyzes the final step in the biosynthetic pathway which is the methylation of protocatechualdehyde (3,4-dihydroxybenzaldehyde) at position 3, producing vanillin (4-hydroxy-3-methoxy-benzaldehyde). The activity of the enzyme is detected in tissue extracts of green vanilla beans, leaves and tissue culture but the enzyme has yet to be purified and characterized. Several attempts have been made to purify POMT from tissue extracts, but the activity co-migrates with caffeic acid methyl transferase (COMT). The co-purification of enzyme activities and the structural similarity of the substrates suggested there may be similarities in amino acid sequences of the two enzymes. Degenerate oligos were designed based on conserved sequences among COMTs cloned from other species. The oligos amplified two distinct 400 bp fragments from a vanilla embryo cDNA library. A full length cDNA clone was obtained for more abundant fragment. The amino acid sequence is 60%–62% identical to other monocot COMTs. The clone was expressed as a His-tagged protein in *E. coli* and purified. Both caffeic acid and protochatechulaldehyde are substrates for the proofed enzyme with protochatechulaldehyde being preferred. This suggests that the isolated clone encodes POMT involved in vanillin biosynthesis.

0800–0900

S06–P–96

ESSENTIAL OILS FROM ARGENTINEAN AROMATIC PLANTS

Hector R. Juliani*[1], Fernando N. Biurrun[2], Veronica Castellano[3], James E. Simon[1], Julio A. Zygadlo[3]

[1]New Use Agriculture and Natural Plant Products, Program, Rugers Univ., Foran Hall, New Brunswick, NJ 08901 USA; [2]Instituto de Desarrollo de los Llanos de La Rioja–National Univ. of La Rioja, La Rioja, Argentina; [3]Instituto Multidisciplinario de Biologia Vegetal (IMBIV-CONICET), Cordoba, Argentina

In Argentina, local people broadly use aromatic plants in popular medicine. This important group of the native flora is utilized in a great variety of

commercial products. In the last years there was a tremendous increase in their consumption. Since very few species are cultivated, they are mainly collected from the wild to meet the growing demands of industry. As a result, natural populations are declining and genetic diversity has been lost, with concerns of even greater loss in the future. Prior work indicated that many of the therapeutical effects of these species could be attributed predominantly or even exclusively to their essential oils. A research association was established between Rutgers and Argentinean Universities to identify plants of potential commercial interest for future cultivation and conservation programs. Plants were collected from La Rioja province (Los Llanos region) and their essentials oils were subjected to GC–MS analysis. The species included in this study were *Aloysia grattissima*, *Aloysia polystachya, Baccharis tenella, Chenopodium ambrosioides, Lantana xenica, Lippia turbinata* and *Tagetes minuta*. The chemical composition of *L. xenica,* and *B. tenella* was reported for the first time. The majority of these species are utilized commercially and a regional market survey showed that *Lippia turbinata*, locally known, as "Poleo" was the most used aromatic plant for the preparation of a wide range of commercial items for medicinal application.

0800–0900
S06–P–97
COLORIMETRIC MEASUREMENT OF CITRAL IN LEMON SCENTED ESSENTIAL OILS USING SCHIFF'S REAGENT

N. Dudai*, O. Larkov, E. Lewinsohn

Division of Aromatic Plants, ARO Newe Ya'ar Research Center, P.O. Box 1021, Ramt Yishav, Israel

Citral is a key component of lemon scented essential oils. In our breeding programs it is necessary to screen hundreds of samples rapidly for their citral content. The current method based on GLC analysis is expensive and time consuming. Here we describe a colorimetric method for citral determination based on the Schiff's reaction of citral. The method is rapid, reproducible and simple. It must, however, be calibrated against GLC. The method is applicable only to samples in which citral is the preponderant aldehyde present.

0800–0900
S06–P–98
ESSENTIAL OILS AS ALLELOPATHIC AGENTS

N. Dudai*, M. Ben-ami, O. Larkov, R. Chaimovich, D. Chaimovitsh

Division of Aromatic Plants, ARO Newe Ya'ar Research Center, P.O. Box 1021, Ramt Yishav, Israel

Essential oils inhibit seed germination, in part due to their cytotoxicity. The objective of this study was to investigate whether seed inhibition arises from the activity of applied essential oils or, alternatively, their metabolic by products. Addition of dry leaves of *Micromeria fruticosa* or *Origanum siriacum* (0.3%–1% of dry soil weight) to the soil resulted in low germination. Our results indicate that essential oils components such as citral, pulegone, carvacrol and thujone are absorbed and concentrate mainly in the seed embryo, in soil and laboratory setup. We also found that the original composition of applied essential oil compounds can be changed, apparently due to enzyme activities present in the seeds. Newly formed compounds can be either less toxic to the seed than the parent compounds (e.g., citral vs. its metabolic byproducts geraniol and nerol), or more toxic than the parent compound (e.g., carvacrol vs. thymoquinone). These results demonstrate the potential of essential oils as allelopathic agents and provide an insight into their mode of action. This information has been used to develop new methods for converting essential oils to new natural chemicals. The biotechnological potential of using germinating seeds as a tool to synthesize novel derivatives will be featured.

0800–0900
S06–P–99
TAXONOMICALLY USEFUL CHIRAL VOLATILE MARKERS FOR DIFFERENTIATION OF CLOSELY RELATED AROMATIC PLANTS

Uzi Ravid*, N. Dudai, E. Lewinsohn, O. Larkov, L. Frieman

Dept. of Aromatic Plants, ARO Newe Ya'ar Research Center, P.O. Box 1021, Ramt Yishav, Israel

The significance of enantiomers as chemical markers within species is demonstrated by chiral monoterpene hydrocarbons and oxygenated monoterpenes detected in fresh herbs such as *Origanum majorana, O. syriacum, O. dayi, O. vulgare, O. ramonense, Rosemarinus officinalis, Salvia fruticosa* and *S. officinalis*. The characterization of the species or hybrids is important for the taxonomic distinction, as well as for a reliable assessment of the quality of aromatic plants. The enantiomeric composition of essential oil components such as camphor, limonene, _-pinene, _-terpineol, cis- and trans-sabinene hydrate, cis- and trans-sabinene hydrate acetate and others is of pivotal importance for chemotaxonomic implications. A chiral monoterpene may show differences in enantiomeric composition when appearing in closely related aromatic plant species and their hybrids. This can be used to differentiate herb cultivars. The enantiomeric composition of chiral volatile monoterpenes was determined in fresh aromatic plants by method headspace-solid phase microextraction-chiral gas chromatography–mass spectrometry.

0800–0900
S06–P–100
DIFFERENTIATION OF KAVA EXTRACTS FROM VARIOUS PLANT PARTS

Ernesto Brovelli*, Puri David, Amitabh Chandra, Rodney Johnson, Monika Zhu

Nutrilite, 19600 6th Street, Lakeview, CA 92567-8403 USA

Kava (*Piper methysticum* F.) is a leafy shrub in the Piperaceae family from the islands of the South Pacific. For centuries, kava has been used as a ritual drink and social beverage, as well as a traditional medicine for a variety of ailments. Studies have indicated that extracts of kava are as effective against stress and anxiety as some conventional pharmaceutical treatments. A group of low molecular weight compounds, kavalactones, have been proposed to be the active constituents. While most kava extracts are from either roots or rhizomes, there are extracts derived from other plant parts or combinations thereof. For the present study, we sought to characterize kava extracts based on their chemical composition. The analysis was conducted by reverse phase HPLC using a PDA detector and plant material consisted in dehydrated rhizomes, roots, stems and leaves. Total kavalactones for roots, rhizomes, stems and leaves were present at 66, 51, 20, and 17 mg/g, respectively. Five kavalactones were analyzed: methysticin, dihydromethysticin, kavain, dihydrokavain, desmethoxyyangonin and yangonin. All were present in roots, rhizomes, and stems, except yangonin that was not found in leaves. Variation in the chemical profile as a function of region of origin was also analyzed. Results point at qualitative differences among plant organs and at a possible means of distinguishing adulterations.

0900–0940
S06–O–101
LINKING CHEMISTRY AND GENOMICS FOR THE STUDY OF SECONDARY METABOLISM IN AROMATIC AND MEDICINAL PLANTS

Efraim Lewinsohn*

Newe Ya'ar Research Center, Agricultural Research Organization, P.O. Box 1021, Ramat Yishay, 30095, Israel

The study of the biosynthesis of secondary metabolites and the genes involved in these processes has been greatly facilitated by novel genomic approaches developed during the past few years. Many of the biosynthetic pathways dedicated to secondary metabolism and the enzymes involved in these pathways have apparently evolved from the much better studied primary biosynthetic pathways. Therefore, by exploiting similarities between functionally related genes, the isolation of novel genes involved in the formation of unique natural products may be possible. To implement this novel approach, appropriate tissues in the proper physiological state, where the compounds of interest are produced in significant levels, are identified. Next, sequence information on large numbers (thousands) of different ESTs (expressed sequence tags) originating in these tissues is obtained. The information obtained is examined en masse using bioinformatic computer algorithms and, based on DNA similarities and the patterns of expression of individual ESTs, predictions on the physiological and biochemical role of individual ESTs are made. Identity and biochemical function of the particular EST in question can then be confirmed by functional expression experiments. A few examples of such genomic projects aimed at isolating and characterizing genes involved in the formation of key metabolites will be reviewed. Some of the genes responsible for the formation of the phenylpropanoids prominent in the essential oil of sweet basil and in the formation of the many compounds that compose the fragrance of roses have been identified utilizing this approach. The potential of utilizing these genes for the improvement of the quality properties of aromatic plants and other agricultural produce will be discussed.

0940–1000
S06–O–102
HIGH PRODUCTIONS OF ANTIMALARIAL AGENTS OBTAINED FROM TRANSGENIC *ARTEMISIA ANNUA* L. RESULTED BY OVEREXPRESSION OF FARNESYL PYROPHOSPHATE SYNTHASE (FPS) GENE.

Pornnaree Cheewasakulyong, Waleerat Banyai, Chalermpol Kirdmanee, Sumalee Kamchonwongpaisan, Kanyaratt Supaibulwatana*

Dept. of Biotechnology, Faculty of Science, Mahidol Univ., Rama 6 Road, Bangkok, Bangkok, Thailand, 10400

Malaria is a serious public health problem in many parts of the world and became more virulently affected to people due to the resistance of some parasites to the Antimalarial drugs. Artemisinin and its derivatives derived from *Artemisia annua* L., the sesquiterpene lactone having endoperoxide group could potentially cure the malarial disease. The highest contents are found in parts of leaf and flower, but may exist in low amounts resulted by inappropriate factors such as cultivars, geographic localization or extraction procedures. In this present study, improvement of artemisinin productions in plant parts was investigated by controlling of the proposed key enzyme gene, the farnesyl pyrophosphate synthase that involve in the artemisinin biosynthetic pathway. The recombinant plasmid comprising with FPS gene from *A. annua* was cloned into *Agrobacterium tumefaciens* strain LBA4404 and successfully transformed to in vitro plant to induce overexpression of FPS enzyme. After selection through series of selective media containing hygromycin for 6 months, positive band of hpt gene was detected in the transformed lines. It was showed the different characteristics among the transformed calli, which are compact and deep green in color than those from control. Artemisinin measurement was established using spectrophotometer at OD259 and HPLC. Ten times over than control of artemisinin content was observed in transformed *A. annua* leaves. It was confirmed for high antimalarial activity in those transformed lines when tested the crude extracts with *P. falciparum*.

1000–1020
S06–O–103
IMPLEMENTATION OF MOLECULAR TECHNIQUES (RAPDS, AFLPS) ON CAMOMILE (*CHAMOMILLA RECUTITA* (L.) RAUSCH.) FOR GENOTYPING AND MARKER DEVELOPMENT

Carola Wagner*, Richard A. Marquard, Wolfgang Friedt, Frank Ordon

Justus-Liebig Univ., Institute of Crop Science and Plant, Heinrich-Buff-Ring 26-32, IFZ, Giessen, Hesse, Germany, D-35392

Camomile varieties of different provenience can be distinguished by morphological and especially by physiological traits. However, these traits vary under different environmental conditions leading to major difficulties in the discrimination of known chemotypes and cultivars. In this respect PCR-based molecular techniques like RAPDs and AFLPs are very useful tools to distinguish and characterise genotypes of different provenience rapidly and reliably on the DNA-level independently from ecological factors. Therefore, investigations were carried out to establish these molecular techniques on camomile and genetic similarity was estimated based on data obtained by RAPD and AFLP analyses. The investigations were carried out on released cultivars as well as populations and twice self-pollinated lines. By cluster analysis as well as by principle coordinate analysis based on genetic similarity data (Jaccard, 1908) obtained from the analysis of 20 RAPD primers and 16 AFLP EcoRI+3/MseI+3 primer combinations genotypes were grouped according to their different provenience. Regarding the self-pollinated lines differing in the (-)-alpha-bisabolol content a high degree of homogeneity within the lines and a relatively low genetic similarity between the ´lines´ were determined by RAPDs. Consequently, crosses between these lines were carried out in order to develop a segregating population suited for molecular marker development for the (-)-alpha-bisabolol content. In this respect, the hybrid character of the F1-plants has been efficiently proved by RAPDs, already. Results elucidate that molecular markers are useful tools in genotyping and estimation of genetic diversity in camomile. Besides this, these techniques can be used for the development of molecular markers, which are of special importance with regard to various substances of the essential oil, because of facilitating pre-flowering selection resulting in a more effective breeding process.

1020–1040
S06–O–103–Å
TO BE ANNOUNCED

1400–1420
S06–O–104
DNA FINGERPRINTING IN *HYDRASTIS CANADENSIS* USING RAPD ANALYSIS

K.J. Kelly*, J. Jung, A. Frary

Mount Holyoke College, South Hadley, MA USA

Hydrastis canadensis (goldenseal) is a perennial wildflower native to eastern North America. Listed as an endangered species by the Convention of International Trade in Endangered Species (CITES), goldenseal is considered one of the "ten most wanted" species on the international trade market by the World Wildlife Fund. The popularity of goldenseal has led to an increased interest in both cultivated and wild harvested forms of the herb. Because propagation of Hydrastis by seed has proven to be problematic, the preferred method in cultivation is clonal propagation via root cuttings. Plants reproduce in the wild clonally until they reach sexual maturity, after 2–3 years. Because mature plants are favored for medicinal use, the genetic variability that would be produced via sexual reproduction is reduced through harvesting of wild populations. These factors may lead to a decrease in germplasm in both cultivated and wild populations of goldenseal. Knowledge about the levels of genetic variability within and among populations could assist in crop production and reintroduction strategies. In this study, we analyzed several populations of *Hydrastis canadensis* for genetic diversity within and among populations. The samples are from cultivated populations in Massachusetts and wild populations from various locations in Ohio, West Virginia and New York. We used the RAPD analysis technique to generate DNA profiles from our samples and to estimate genetic relatedness within and between populations. Preliminary results for the cultivated material show 72%–86% similarity among the four populations tested. These results are in accordance with what one might expect to see in a highly cultivated genus, but do not explain the high degree of genetic similarity shown in goldenseal given that the species has only recently been cultivated. Data is currently being analyzed for the wild goldenseal populations, which should shed additional light on this issue.

1420–1440
S06–O–105
METHYL JASMONATE INCREASES SAPONIN CONTENT IN BIOREACTOR CULTURE OF GINSENG (*PANAX GINSENG* C.A. MEYER) ADVENTITIOUS ROOTS

Yun-Soo Kim, Eun-Joo Hahn, Kee-Yoeup Paek*

Research Center for the Development, of Advanced Horticultural Tech., Chungbuk National Univ., Cheongju, Chungbuk, Republic of Korea, 361-763

Ginseng (*Panax ginseng* C.A. Meyer) is traditionally considered one of the most potent medicinal plants that has been used for centuries as a health tonic. The most important active component in ginseng root is saponin, of which more than 20 different types have been identified. Current advances in plant biotechnology allowed production of saponin through adventitious root culture of ginseng in bioreactors. The adventitious root is an efficient means of saponin production due to fast root growth and stable metabolite productivity but the saponin content is still lower than that in field-cultivated ginseng root, which is a main problem to solve. To increase saponin content, ginseng adventitious roots were cultured in a 20-L balloon type airlift bioreactor for 40 days and different types and concentrations of elicitors were treated for 10 days. The result confirmed that the treatment of 50 μmol methyl jasmonate for 7 days maximized saponin content. Saponin content started to increase from the first day of treatment, peaked at 7 days after culture. Research is still under way to determine the correlation of salt concentrations in the culture medium and the effect of methyl jasmonate on saponin production.

1440–1500
S06–O–106
SECONDARY METABOLITES OF CALLUS AND REGENERANTS OF ST. JOHN'S WORT (*HYPERICUM PERFORATUM* L.)

Majid Azizi*[1], Reza Omidbaigi[1], Alberto Dias[2], Hossain Aroiee[1]

[1]Ferdowsi Univ., Dept. of Horticulture, College of Agriculture, Mashhad, Iran; [2]Dept. of Biology , Minho Univ. , Portugal

St. John's Wort (*Hypericum perforatum* L.) is an important medicinal plant used in the pharmaceutical industry . In this research we used the seed of cv. Topas as our initial plant material and from MS + 2,4-D and kinetin for callogenesis and from BAP and NAA for shoot regeneration . All callus and regenerants were analyzed by HPLC-DAD for secondary metabolites concentration. Our results show high regeneration capacity of Hypericum perforatum callus and there is a good correlation between BAP concentration and number of regenerants per each callus clump . All callus showed red dots after 8 weeks. In spite of the presence of red color there was no detectable hypericin and pseudohypericin in callus but we did detect hypericin and other metabolites in the regenerants. All regenerants had special dots that produced secondary metabolits specially hypericin and pseudohypericin. Other secondary metabolites (hyperforin, adhyperforin, chlorogenic acid, isochlorogenic acid and apigenin) content in regenerants were higher than callus.

1500–1520
S06–O–106–A
TO BE ANNOUNCED

15200–1540
S06–O–106–B
TO BE ANNOUNCED

1540–1600
S06–O–106–C
TO BE ANNOUNCED