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Inhibitory effect of CuSO₄ on Citrus pollen germination and pollen tube growth and its application for the production of seedless fruit/ Carlos Mesejo, Amparo Martinez-Fuentes, Carmina Reig, Fernando Rivas, Manuel Agusti,,

Plant Science, Volume 170, Issue 1, January 2006, Pages 37-43, ISSN 0168-9452, DOI: 10.1016/j.plantsci.2005.07.023.
(<http://www.sciencedirect.com/science/article/pii/S0168945205002736>)

Abstract:

The addition of 25 mg l⁻¹ of CuSO₄·5H₂O to the germination media significantly inhibited the in vitro pollen germination of 'Fortune' mandarin. Furthermore, when this was applied 8 h after in vitro germination it halted pollen tube development. The same concentration applied to 'Clemenules' mandarin flowers, at the preanthesis stage and 2 h prior to pollination with 'Fortune' mandarin pollen, arrested pollen tubes in the upper region of the style, and the average number of seeds per fruit was significantly reduced by 96%. Finally, 25 mg l⁻¹ of CuSO₄·5H₂O when applied at full bloom to entire 'Afourer' tangor trees under cross-pollination conditions, significantly reduced the average number of seeds per fruit by 55-81% and significantly increased the percentage of seedless fruits, without reducing fruit yield.

Keywords: Citrus; Copper; Parthenocarpy

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Supercritical fluid extraction of limonoids and naringin from grapefruit (*Citrus paradisi* Macf.) seeds/Uun Yu, Deepak V. Dandekar, Romeo T. Toledo, Rakesh K. Singh, Bhimanagouda S. Patil

Food Chemistry, Volume 105, Issue 3, 2007, Pages 1026-1031, ISSN 0308-8146, DOI: 10.1016/j.foodchem.2007.04.062.
(<http://www.sciencedirect.com/science/article/pii/S0308814607004219>)

Abstract:

Limonoids and naringin were extracted from grapefruit (*Citrus paradisi* Macf.) seeds by a supercritical carbon dioxide (SC-CO₂) extraction technique. Prominent limonoids such as limonin and limonin-17- β -D-glucopyranoside (LG) and flavonoid naringin were quantified for process optimization. Extraction was completed in two stages. In stage one less polar limonin was extracted using SC-CO₂ while in stage two extraction of high polar LG and naringin were completed using SC-CO₂ modified by ethanol as co-solvent. Extraction parameters were studied using Box-Behnken experiment design. Response surface analysis (RSA) of the data was completed to determine effects of variables on extraction efficiency. Highest yield of limonin (6.3 mg/g seeds) was achieved at 48.3 MPa pressure, 50 [degree sign]C temperature and 60 min of extraction time where as highest yield of LG (0.62 mg/g seeds) was achieved at 41.4 MPa pressure, 60 [degree sign]C temperature and 30% ethanol concentration in 40 min. Highest yield of naringin (0.2 mg/g seeds) was achieved at 41.4 MPa pressure, 50 [degree sign]C temperature and 20% ethanol concentration in 40 min. In all the experiments, mobile phase flow rate was kept constant at 5.0 L/min. The results demonstrated environmentally friendly, practical application of

supercritical CO₂ extraction of limonoids and flavonoids from grapefruit seeds.

Keywords: Citrus; Bioactive compounds; Box-Behnken design; Limonin; Limonin-17-[beta]-d-glucopyranoside; Naringin

Influence of desiccation and rehydration on the survival of polyembryonic seed of *Citrus suhuiensis* cv. limau madu/M.A. Makeen, M.N. Normah, S. Dussert, M.M. Clyde

Scientia Horticulturae, Volume 112, Issue 4, 14 May 2007, Pages 376-381, ISSN 0304-4238, DOI: 10.1016/j.scienta.2006.12.050.
(<http://www.sciencedirect.com/science/article/pii/S0304423806005322>)

Abstract:

A study was carried out to investigate the influence of desiccation and freezing followed by various presowing rehydration procedures on the desiccation sensitivity of the seed of *Citrus suhuiensis* cv. limau madu. The freshly harvested seeds of limau madu were desiccated under a broad range of relative humidity (RH) to various equilibrium water contents (g H₂O g⁻¹ dw). The desiccated and desiccated-frozen seeds were either directly sown under germination conditions or subjected to presowing rehydration procedures: seed preheating, prehumidification and osmoconditioning. The hydrated and desiccated seeds were sown in controlled germination conditions and the survival was evaluated 4-6 weeks after sowing. The results showed that desiccation progressively reduced the percentage of normal seedling of the seeds of limau madu and the viability is almost lost at water contents below 0.08 g H₂O g⁻¹ dw. The estimated desiccation sensitivity was substantially high (WC₅₀ = 0.143 g H₂O g⁻¹ dw) when the desiccated seeds were rapidly rehydrated (uncontrolled rehydration). In contrast, seed prehumidification, preheating and osmoconditioning (controlled rehydration procedures) markedly enhanced normal seedling percentages decreasing the estimated values of WC₅₀ (between 0.08 and 0.127 g H₂O g⁻¹ dw). While the rapidly rehydrated desiccated-frozen seeds were almost killed at water content of 0.15 g H₂O g⁻¹ dw, prehumidification and preheating have noticeably increased percentage of frozen seeds survival at the same water content. However, at water content of 0.21 g H₂O g⁻¹ dw preheating significantly ($P < 0.05$) increased percentage of normal seedling of the frozen seeds. Seed desiccation markedly reduced the percentages of germinated seeds with multiple seedlings. Seed controlled rehydration remarkably increased the survival of polyembryos. The beneficial effect of seed controlled rehydration on the survival of the desiccated seeds was pronounced at medium water contents (0.08-0.25 g H₂O g⁻¹ dw).

Keywords: Citrus suhuiensis; Desiccation; Freezing; Rehydration

Production of mandarin + pummelo somatic hybrid citrus rootstocks with potential for improved tolerance/resistance to sting nematode/Jude W. Grosser, J.L. Chandler, Larry W. Duncan

Scientia Horticulturae, Volume 113, Issue 1, 5 June 2007, Pages 33-36, ISSN 0304-4238, DOI: 10.1016/j.scienta.2007.01.033.
(<http://www.sciencedirect.com/science/article/pii/S0304423807000581>)

Abstract:

Sting nematode (*Belonolaimus longicaudatus* Rau) has become a primary factor limiting citrus production in localized regions of the central Florida sandridge citrus production area, making the development of resistant rootstocks a new breeding objective. In efforts to develop a replacement rootstock for the widely adapted sour orange, our focus has

been on somatic hybridization of selected mandarin + pummelo combinations [Grosser, J.W., Gmitter, Jr., F.G., 1990. Protoplast fusion and citrus improvement. *Plant Breed. Rev.* 8, 339-374; Ananthakrishnan, G., Calovic, M., Serrano, P., Grosser, J.W., 2006. Production of additional allotetraploid somatic hybrids combining mandarins and sweet oranges with pre-selected pummelos as potential candidates to replace sour orange rootstock. *In Vitro Cell. Dev.: Plant* 42, 367-371], since sour orange is probably an introgression hybrid of mandarin and pummelo as suggested by molecular marker analyses [Nicolosi, E., Deng, Z.N., Gentile, A., La Malfa, S., Tribulato, E., 2000. Citrus phylogeny and genetic origin of important species as investigated by molecular markers. *Theor. Appl. Genet.* 100, 1155-1166; Gulsen, O., Roose, M.L., 2001. Lemons: diversity and relationships with selected Citrus genotypes as measured with nuclear genome markers. *J. Am. Soc. Hort. Sci.* 126, 309-317]. Somatic hybrid plants were produced from four new mandarin (*C. reticulata* Blanco) + pummelo (*C. grandis* L. Osbeck) parental combinations by fusing embryogenic suspension culture-derived protoplasts isolated from selected mandarins with leaf protoplasts of pummelo seedlings previously selected for tolerance/resistance to the sting nematode (*B. longicaudatus* Rau) as follows: *Amblycarpa* mandarin + 'Liang Ping Yau' (seedling) pummelo seedling SN7; *Amblycarpa* mandarin + 'Hirado Buntan Pink' (HBP) pummelo seedling SN3; Murcott tangor + pummelo seedling SN3; and Shekwasha mandarin + pummelo seedling SN3. Somatic hybridization was verified by ploidy analysis (via flow cytometry) and RAPD analyses. Mandarin parents were selected for wide soil-adaptation and ability to produce friable embryogenic callus lines. Pummelo seedlings used as leaf parents were identified from a previous screen of large seed populations (200 each) from four pummelos for resistance to sting nematode as follows: 'Hirado Buntan Pink'; 'Red Shaddock'; 'Large Pink Pummelo' and a seedling pummelo of 'Liang Ping Yau'. Ten resistant/tolerant pummelo seedlings were selected from the 800 pummelo seeds planted in the screen for further study. The four new somatic hybrids have been propagated to evaluate their horticultural performance and resistance to the sting nematode. These potential somatic hybrid rootstocks should also have potential to control tree size due to polyploidy.

Keywords: Citrus tissue culture; Protoplast fusion; Tetraploid; Tree size control

Development of seedless and Mal Secco tolerant mutant lemons through budwood irradiation/O. Gulsen, A. Uzun, H. Pala, E. Canihos, G. Kafa, *Scientia Horticulturae*, Volume 112, Issue 2, 26 March 2007, Pages 184-190, ISSN 0304-4238, DOI: 10.1016/j.scienta.2006.12.040. (<http://www.sciencedirect.com/science/article/pii/S0304423806004973>)

Abstract:

Mal secco (caused by *Phoma tracheiphila* (Petri) Kantsch. and Gik.) is the most destructive fungal disease of lemon plantations worldwide and seedless lemons would be preferred by most consumers. Five dosage levels, 0, 3, 5, 7, and 9 kiloradian (krad), of cobalt (⁶⁰Co) gamma irradiation were applied to budstick of 'Kutdiken' lemon (*Citrus limon* (L.) Burm. f.) clone KT-2A. Mutations were stabilized in three vegetative generations. Three hundred fifty-eight and 478 M1V3 (mutation one and vegetation three) plants were evaluated for seed number and mal secco tolerance in the field and the greenhouse, respectively. LD50 was around 5 krad gamma irradiation for 'Kutdiken'

lemon. The seed number varied from 0 to 34 per fruit. The level of mal secco tolerance also varied significantly among the plants from 1.0 (no symptom) to 4.3 (high level of disease occurrence). The stable seedless and mal secco tolerant plants were obtained from 5 and 7 krad irradiation: the three mutants from 5 krad irradiation gave more lemon-like fruits, while 7 krad irradiation caused altered tree morphology and early maturation of fruits. This study shows considerable potential for lemon cultivar improvement aiming to obtain seedless and mal secco tolerant lemons.

Keywords: Citrus limon; Mutation breeding; Gamma irradiation; Mal secco; Phoma tracheiphila

Effective pollination period in 'Clemenules' mandarin, 'Owari' Satsuma mandarin and 'Valencia' sweet orange/Carlos Mesejo, Amparo Martinez-Fuentes, Carmina Reig, Manuel Agusti

Plant Science, Volume 173, Issue 2, August 2007, Pages 223-230, ISSN 0168-9452, DOI: 10.1016/j.plantsci.2007.05.009.

(<http://www.sciencedirect.com/science/article/pii/S0168945207001719>)

Abstract:

The effective pollination period (EPP) determines the success of seed set in Citrus. In this research, the EPP was studied in three citrus species with different seed set abilities, *C. clementina* Hort. ex Tanaka, *C. unshiu* Marcovich and *C. sinensis* (L.) Osbeck, so as to identify the factors affecting seed set and flower receptivity. The objective of this research was to enhance agronomical efforts [C. Mesejo, A. Martinez-Fuentes, C. Reig, F. Rivas, M. Agusti, The inhibitory effect of CuSO₄ on Citrus pollen germination and pollen tube growth and its application for the production of seedless fruit, *Plant Sci.* 170 (2006) 37-43] to prevent seed presence in fruits given that seedlessness is the main factor of quality for fresh citrus fruit consumption.

The EPP was determined and the factors affecting the EPP were evaluated through fluorescence microscopy [R.R. Williams, Techniques used in fruit set experiments, in: R.R. Williams, D. Wilson (Eds.), *Towards Regulated Cropping*, London Grower Books, 1970, pp. 57-61; J. Sanzol, P. Rallo, M. Herrero, Stigmatic receptivity limits the effective pollination period in 'Agua de Aranjuez' pear, *J. Am. Soc. Hort. Sci.* 128 (2003) 458-462]. The EPP, measured as the capacity to set seeds after pollination with 'Fortune' mandarin pollen, was 8-9 days for *C. clementina* and *C. sinensis*, and 2-3 days for *C. unshiu*. Pollen tube development did not appear to be a limiting factor, whereas *C. clementina* and *C. sinensis* stigmatic receptivity closely fit the effective pollination period and thus appeared to be the main factor determining seed set in these two species. In *C. unshiu*, shorter ovule longevity appeared to be the factor determining seed set.

We conclude that Citrus flower receptivity is genotype-dependent either on ovule longevity, as in *C. unshiu*, or stigmatic receptivity, as in *C. clementina* and *C. sinensis*.

Keywords: *C. clementina*; *C. sinensis*; *C. unshiu*; Flower receptivity; Seed set

Hydrotropic extraction of bioactive limonin from sour orange (*Citrus aurantium* L.) seeds/Deepak V. Dandekar, G.K. Jayaprakasha, Bhimanagouda S. Patil,,

Food Chemistry, Volume 109, Issue 3, 1 August 2008, Pages 515-520, ISSN 0308-8146, DOI: 10.1016/j.foodchem.2007.12.071.
(<http://www.sciencedirect.com/science/article/pii/S0308814608000435>)

Abstract:

Limonoids are potential bioactive compounds present only in citrus among fruits and vegetables. A new process for extraction of limonoid aglycones from sour orange (*Citrus aurantium* L.) seeds was investigated using aqueous hydrotropic solutions. The extraction efficiency was dependent on hydrotrope concentration, extraction temperature and percent of raw material loaded. Two hydrotropes such as sodium salicylate (Na-Sal) and sodium cumene sulphonate (Na-CuS) were studied using Box-Behnken experiment design. Response surface analysis (RSA) of data was performed to study the effect of parameters on extraction efficiency. Prominent limonoid aglycone such as limonin was extracted and quantified for process optimization. Both hydrotropes gave maximum limonin yield at 2 M concentration, extraction temperature of 45 [degree sign]C and 10% solid loading. A maximum limonin yield of 0.65 mg/g seeds was obtained using Na-CuS whereas only 0.46 mg/g seed was obtained using Na-Sal. Using this process, the use of organic solvents can be reduced dramatically to keep the process environmental friendly for the extraction of bioactive compounds.

Keywords: Sodium salicylate; Sodium cumene sulphonate; Limonin

Seed abortion of 'Tosa-Buntan' pummelo pollinated with soft-X-irradiated pollens/Tsuneo Ogata, Tomoya Takeichi, Kazunori Matsunaga, Kojiro Hasegawa, Shinzo Yamane, Keita Sugiyama

Scientia Horticulturae, Volume 116, Issue 2, 4 April 2008, Pages 180-185, ISSN 0304-4238, DOI: 10.1016/j.scienta.2007.12.006.
(<http://www.sciencedirect.com/science/article/pii/S0304423807004244>)

Abstract:

Cross-pollination was performed with soft-X-irradiated hyuga-natsu pollens (1000 Gy) for 'Tosa-Buntan' pummelo (*Citrus grandis* (L.) Osbeck). This resulted in the transformation of large and complete seeds into small and empty ones (practically seedless). Although fruit set, fruit retention, total soluble solids content (TSS) and titratable acidity of the juice were not affected, decrement in the fruit size was observed. Two weeks after the pollination, endosperm cell division with free nuclei began in both the non-irradiated and irradiated pollen treatment conditions. Seven weeks after pollination, endosperm division with the cell wall occurred in the non-irradiated pollen treatment conditions; however, the endosperm development ceased in most ovules that underwent the irradiated pollen treatment, and the ovules remained in their free nuclear stage. The delayed degeneration of the ovules, following successful fertilization and commencement of endosperm cell division, allow these seedless fruits to be categorized as pseudo-parthenocarpic.

Keywords: Citrus grandis; Soft-X-ray; Pseudo-parthenocarpic

Non-destructive seed detection in mandarins: Comparison of automatic threshold methods in FLASH and COMSPIRA MRIs/P. Barreiro, C. Zheng, Da-Wen Sun, N. Hernandez-Sanchez, J.M. Perez-Sanchez, J. Ruiz-Cabello,

Postharvest Biology and Technology, Volume 47, Issue 2, February 2008, Pages 189-198, ISSN 0925-5214, DOI: 10.1016/j.postharvbio.2007.07.008. (<http://www.sciencedirect.com/science/article/pii/S092552140700230X>)

Abstract:

Magnetic resonance imaging was used to acquire images of the internal structure of mandarins for non-destructive seed identification. Two different types of fast MRI sequences were investigated: a gradient echo and a spiral-radial, with 484 ms acquisition time for the former compared to 240 ms for the latter. The radial-spiral option allows over-sampling of the central area of the k-space maintaining the contrast within the MRI images and so the feasibility of seed segmentation. Three segmentation techniques were applied for image post-processing: region-based, one-dimension histogram variance, and two-dimension histogram variance, among which the latter procedure has been demonstrated to give the most promising results. Image features including perimeter, compactness, maximum distance to the gravity centre, and aspect ratio were employed in a linear discriminant function, by which seed identification of mandarins could be achieved with 100% accuracy using radial-spiral sequence and 98.7% accuracy with gradient echo images.

Keywords: Image analysis; Classification; Citrus; Internal quality; Fruit

Evaluation of an organic treatment for post-harvest control of crown rot of banana/C. Demerutis, L. Quiros, A. Martinuz, E. Alvarado, R.N. Williams, M.A. Ellis

Ecological Engineering, Volume 34, Issue 4, Ecological management and sustainable development in the humid tropics of Costa Rica, 5 November 2008, Pages 324-327, ISSN 0925-8574, DOI: 10.1016/j.ecoleng.2007.02.004. (<http://www.sciencedirect.com/science/article/pii/S0925857407000663>)

Abstract:

An organic treatment for control of crown rot disease of banana was developed and evaluated at EARTH University in Costa Rica. Studies were conducted to evaluate the efficacy of Biocto 6 (seed extract from citrus) in combination with the wax-based adjuvant Verdiol for control of post-harvest crown rot of banana. The standard commercial fungicide treatment (thiabendazol, imazalil and ammonium sulfate) and an untreated control were included for comparison. Bananas with the various treatments were processed using standard commercial procedures and stored in a refrigerated chamber that was modified to simulate commercial transport, distribution and controlled ripening for exported bananas. Fruit clusters were evaluated for percent weight loss, ripening in storage and crown rot disease severity. At the end of the 28-day storage period, there were no significant differences in percent weight loss between any of the treatments. There was no significant difference in ripening (maturity level) between the organic treatment and the commercial fungicide standard in 2 years of testing. In 2003, the untreated control had a significantly higher maturity rating than the organic or standard fungicide treatment. However, there were no significant differences in any of the treatments in maturity level in 2005. There was no significant difference between the organic and standard fungicide treatment for crown rot control and both treatments had significantly less crown rot than the untreated control. Results

indicate that Biocto 6 in combination with Verdiol wax provides a new organic alternative for control of post-harvest crown rot of banana.

Keywords: Banana crown rot; Citrus seed extract; Colletotrichum musae; Musa; Post-harvest disease; Organic; Disease control

Gibberellic acid impairs fertilization in Clementine mandarin under cross-pollination conditions/Carlos Mesejo, Amparo Martinez-Fuentes, Carmina Reig, Manuel Agusti

Plant Science, Volume 175, Issue 3, September 2008, Pages 267-271, ISSN 0168-9452, DOI: 10.1016/j.plantsci.2008.04.008.

(<http://www.sciencedirect.com/science/article/pii/S0168945208000988>)

Abstract:

We investigated the effect of gibberellic acid (GA3) in the fertilization of Clementine mandarin cv. 'Clemenules' (Citrus clementina Hort. ex Tan.), a parthenocarpic variety that produces seedless fruit due to its self-incompatible nature, but yields seedy fruits when grown under cross-pollination conditions. Experiments were conducted with on-tree 'Clemenules' flowers and 'Fortune' mandarin pollen (C. clementina Hort. ex Tan. x C. reticulata Blanco), which is sexually compatible with the former. Preanthesis treatment at -2 days after anthesis (-2 DAA) enhanced ovule abortion in both unpollinated and cross-pollinated (at +2 DAA) flowers. In the latter, the number of pollen tubes reaching the ovules was significantly reduced although pollen grains were not treated; thus, fertilization was partially avoided and seed set was reduced. When GA3 was applied at anthesis (0 DAA) at the time of pollination, ovule abortion was again enhanced, and pollen tube growth was completely arrested; thus, fertilization was prevented and seed set was impeded. When GA3 was applied 24 h after pollination (+1 DAA in flowers pollinated at anthesis), pollen tube growth was impaired but not arrested and ovule abortion was enhanced; therefore, fertilization was not prevented but impaired.

We conclude that, when applied the days around anthesis, GA3 (10 mg l⁻¹) impairs fertilization by either enhancing ovule abortion or reducing pollen tube growth, in 'Clemenules' flowers under cross-pollination conditions. The intensity of the response depends on the physiological flower state at the moment of treatment.

Keywords: Citrus; Fruit quality; Ovule abortion; Parthenocarpy; Pollen germination; Pollen tube development

Antifungal potential of some natural products against Aspergillus flavus in soybean seeds during storage/Y.L. Krishnamurthy, J. Shashikala, B. Shankar Naik

Journal of Stored Products Research, Volume 44, Issue 4, 2008, Pages 305-309, ISSN 0022-474X, DOI: 10.1016/j.jspr.2008.03.001.

(<http://www.sciencedirect.com/science/article/pii/S0022474X0800026X>)

Abstract:

The inhibitory effect of cow-dung fumes, captan, leaf powder of Withania somnifera, Hyptis suaveolens, Eucalyptus citriodora, peel powder of Citrus sinensis, Citrus medica and Punica granatum, neem cake and pongamia cake on the growth of Aspergillus flavus in soybean seeds during storage was investigated. Soybean seed was treated with different natural products and the fungicide captan and was stored at ambient conditions for 6 months. Seed samples were withdrawn at monthly intervals and the incidence of seed-borne A. flavus and percentage

germination of the seed was determined. Captan, neem cake, pongamia cake and peel powder of *C. sinensis* reduced the incidence of *A. flavus*. Leaf powder of *W. somnifera*, *H. suaveolens*, *E. citriodora* and peel powder of *P. granatum* also checked the frequency of *A. flavus*. All treatments maintained a high germination percentage of the soybean seeds over a storage period of 6 months. These natural products may be alternatives to chemical fungicides and provide an easy method to protect soybean and other agricultural commodities from *A. flavus* in storage.

Keywords: *Aspergillus flavus*; Natural plant products; Soybean; Germination; Storage

Chloroplast-localized nonspecific lipid transfer protein with anti-fungal activity from rough lemon/Satoshi Nishimura, Satoshi Tatano, Kenji Gomi, Kouhei Ohtani, Takeshi Fukumoto, Kazuya Akimitsu

Physiological and Molecular Plant Pathology, Volume 72, Issues 4-6, July-September 2008, Pages 134-140, ISSN 0885-5765, DOI:

10.1016/j.pmpp.2008.07.003.

(<http://www.sciencedirect.com/science/article/pii/S0885576508000611>)

Abstract:

A full-length cDNA (RlemLTP) from rough lemon that encodes a nonspecific lipid transfer protein was isolated. Results of subcellular localization of RlemLTP fused to a green fluorescence protein indicated that RlemLTP is located in the chloroplast. Transcripts of RlemLTP were detected in leaves and seeds but not in stems and roots. The transcription of RlemLTP was higher in young leaves than in old leaves. Wounding and fungal inoculation induced RlemLTP expression, and transcription levels were increased 6-15 times by these treatments. RlemLTP obtained using an *E. coli* expression system showed anti-fungal activity against *Alternaria alternata* and *Fusarium oxysporum*.

Keywords: Citrus jambhiri; Nonspecific lipid transfer protein; Anti-fungal protein; *Alternaria alternata*; *Fusarium oxysporum* f. sp. lycopersici

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Study of the thermal degradation of citrus seeds/V. Hernandez-Montoya, M.A. Montes-Moran, M.P. Elizalde-Gonzalez,

Biomass and Bioenergy, Volume 33, Issue 9, September 2009, Pages 1295-1299, ISSN 0961-9534, DOI: 10.1016/j.biombioe.2009.05.016.

(<http://www.sciencedirect.com/science/article/pii/S0961953409001056>)

Abstract:

The citrus seeds are one of the principal residues in the juice industry and their utilization can decrease significantly the problems of their final disposal. In this work the thermal degradation of three Mexican citrus seeds: orange (*Citrus sinensis*), lemon (*Citrus Limon*) and grapefruit (*Citrus paradisi*) was studied in nitrogen atmosphere. The two components (embryo and husk) of the seeds were characterized separately. The results showed that the thermal effects are very similar between the three embryos and the three husks. The embryos show higher degradability, superior content of nitrogen and higher heating value than the husks. The thermal degradation of the components of the

three seeds is completed at 600 [degree sign]C and it is considered to be a global process derived from the decomposition of their principal components (cellulose, hemicellulose and lignin). The results suggest that mixing the three entire seeds will not lead to a severe deviation from their individual thermal behavior and that the industry could apply them for carbonization purposes.

Keywords: Citrus seeds; Orange; Lemon; Grapefruit; Thermal degradation

Seedless mechanism of a new mandarin cultivar 'Wuzishatangju' (*Citrus reticulata* Blanco)/Weijia Ye, Yonghua Qin, Zixing Ye, Jaime A. Teixeira da Silva, Lingxiao Zhang, Xiaoying Wu, Shunquan Lin, Guibing Hu

Plant Science, Volume 177, Issue 1, July 2009, Pages 19-27, ISSN 0168-9452, DOI: 10.1016/j.plantsci.2009.03.005.

(<http://www.sciencedirect.com/science/article/pii/S0168945209000910>)

Abstract:

Seedlessness is often a desired characteristic for many types of fruits. A new seedless mandarin cultivar 'Wuzishatangju' and its original seeded cultivar 'Shatangju' were used to study the mechanism of seedlessness from the beginning of fertility. Embryonic development, compatibility of self-pollinated 'Wuzishatangju' and cross-pollinated 'Wuzishatangju' ('Wuzishatangju' x 'Ponkan', 'Wuzishatangju' x 'Shatangju') were studied. Results indicated that the male gametes of 'Wuzishatangju' were healthy. Fertility of the 'Wuzishatangju' embryo sac was normal and the mature embryo sac had one egg, two synergids, three antipodal cells and one big central cell containing two polar nuclei. Embryonic development of cross-pollinated 'Wuzishatangju' was normal. Many globular embryos and a few heart-shaped embryos were observed 2 weeks after cross-pollination (WACP). Heart- and torpedo-shaped embryos were observed at three WACP while embryos reached the torpedo stage at four WACP. Cotyledonary embryos were observed at five WACP and they developed into seeds while funiculi were still existent at seven WACP. However, embryonic development of self-pollinated 'Wuzishatangju' was abnormal and most embryos, which degenerated by 2 weeks after self-pollination (WASP), disappeared and seedless fruits were produced by four WASP. Pollen tubes of cross-pollinated 'Wuzishatangju' could grow normally in the stigma, style and ovary, and they entered into the embryo sac resulting in successful fertilization. The pollen tubes of self-pollinated 'Wuzishatangju' grew well in the stigma and style; however, when they entered into the ovary, they became twisted and could not enter the embryo sac. Results indicate that the activities of the male gamete and the fertility of the embryo sac of 'Wuzishatangju' were functioning normally with no embryo abortion during embryonic development. Gametophytic self-incompatibility (SI) caused seedlessness in 'Wuzishatangju' by blocking fertilization in the ovary.

Keywords: Citrus reticulata Blanco. cv. Wuzishatangju; Embryo sac; Embryonic development; Male gamete; Seedless mechanism; Self-incompatibility

Yield and fruit quality of 'Nova' hybrid [*Citrus clementina* hort. ex Tanaka x (*C. reticulata* Blanco x *C. paradisi* Macfad)] and two Clementine varieties (*C. clementina* hort. ex Tanaka) as affected by self- and cross-pollination/Ioannis E. Papadakis, Eftichios E. Protopapadakis, Ioannis N. Therios
Scientia Horticulturae, Volume 121, Issue 1, 2 June 2009, Pages 38-41, ISSN 0304-4238, DOI: 10.1016/j.scienta.2009.01.011.

(<http://www.sciencedirect.com/science/article/pii/S0304423809000119>)

Abstract:

Low yields of 'Nova' citrus hybrid are common in single variety plantings (plantings consisting of one variety) due to its sexual self-incompatibility. Self-incompatibility may be overcome by cross-pollination with other compatible varieties. Fruit quality and yield of 'Nova' citrus hybrid as well as of the 'SRA63' and 'Marisol' Clementines, when either they were self-pollinated in single variety plantings or each one of the two Clementine varieties was used as a pollinizer for 'Nova' in mixed plantings (plantings consisting of more than one variety), were investigated. The study was carried out for two successive years under the same environmental and cultural conditions using three single variety plantings ('Nova' x 'Nova', 'SRA63' x 'SRA63', 'Marisol' x 'Marisol') and two mixed plantings ('Nova' x 'SRA63', 'Nova' x 'Marisol').

Cross-pollination of 'Nova' with either 'SRA63' or 'Marisol' significantly increased fruit yield of 'Nova' trees and mean fresh weight of 'Nova' fruits without affecting the other fruit quality parameters [rind thickness, percentage of juice, concentration of total soluble solids (TSS) and total acids (TA) in the juice, and TSS/TA ratio]. Although the number of seeds per each 'Nova' fruit significantly increased due to cross-pollination (from 0.7 in 'Nova' x 'Nova' planting to 1.8 and 2.1 in 'Nova' x 'Marisol' and 'Nova' x 'SRA63' plantings, respectively), it remained in a range (≤ 2.1) which is by far acceptable in the fresh fruit market. On the other hand, each fruit produced by cross-pollinated 'Marisol' and 'SRA63' trees with 'Nova' contained an average of 2.4 and 18.6 seeds, respectively. The effects of 'Nova' pollen on the other fruit quality parameters (weight, TSS, TA, TSS/TA, juice content, rind thickness) of 'Marisol' and 'SRA63' were not significant. Therefore, 'Marisol' was proved to be a good pollinizer for 'Nova' and vice versa. Furthermore, 'SRA63' can be used as pollinizer in 'Nova' orchards. Instead, the use of 'Nova' trees as pollinizers in 'SRA63' orchards should be avoided since the seediness of 'SRA63' fruits was increased very much.

Keywords: Total soluble solids; Seedless; Seediness; Titratable acidity; Pollination; Pollinizer

Doron Schneider, Martin Goldway, Nitzan Rotman, Itzhak Adato, Raphael A. Stern, Cross-pollination improves 'Orri' mandarin fruit yield, *Scientia Horticulturae*, Volume 122, Issue 3, 1 October 2009, Pages 380-384, ISSN 0304-4238, DOI: 10.1016/j.scienta.2009.06.009.

(<http://www.sciencedirect.com/science/article/pii/S0304423809002842>)

Abstract:

'Orri', a selection of 'Orha' mandarin [Temple (*Citrus temple hort. ex Y. Tanaka*) x Dancy (*Citrus tangerina hort. ex Tanaka*)], is a new high-quality Israeli mandarin which, in the last decade, has become one of the leading varieties in Israel. 'Orri' has an excellent taste, the rind is deep orange in color and easily removed, and it contains few or no seeds. However, 'Orri' grown in Israel suffers from inadequate yield and no published studies have yet addressed this problem. In the present study we determined that 'Orri' productivity depended on conditions being favorable to cross-pollination. Under cross-pollination conditions a positive correlation ($R^2 = 0.97$) was found between yield per tree and number of fruits per tree, and more than 90% of the fruits exceeded 60 mm: the most profitable size range. These data suggest that the number of fruits per tree, and not fruit size, is

the limiting factor for yield improvement in 'Orri' orchards. Studying seed set showed that 'Michal' mandarin (*Citrus reticulata* Blanco) is a compatible pollenizer for 'Orri' flowers: the number of seeds per 'Orri' fruit increased as the distance from 'Michal' trees decreased. The present study demonstrated that cross-pollination of 'Orri' resulted in yield improvement, yet at the price of increased seed set.

Keywords: Citrus; Cross-pollination; Mandarin; Seediness; Yield

A. Uzun, O. Gulsen, G. Kafa, U. Seday, O. Tuzcu, T. Yesiloglu, Characterization for yield, fruit quality, and molecular profiles of lemon genotypes tolerant to 'mal secco' disease, *Scientia Horticulturae*, Volume 122, Issue 4, 3 November 2009, Pages 556-561, ISSN 0304-4238, DOI: 10.1016/j.scienta.2009.06.031.

(<http://www.sciencedirect.com/science/article/pii/S0304423809003252>)

Abstract:

'Mal secco' is a serious disease of lemon and other citrus species, reduces lemon production, and limits the use of susceptible cultivars especially in the Mediterranean countries, against which there is no effective management system to control the disease. The objective of this study was to determine yield efficiency, tree and fruit characters, and molecular profiles of the selected promising genotypes in lemon breeding program to develop 'mal secco' tolerant lemon cultivars. After 4 years of evaluation, 'Tuzcu 894', a progeny of 'Finike Yerli Yuvarlak' and 'Kutdiken', was designated as promising genotype with high yield, fruit weight, juice content and low seed number contrary to 'Kutdiken' as control. 'Tuzcu 8911' was suitable for dense planting having the highest yield in CV. In addition, these two promising genotypes survived after many years being subjected to artificial and natural *P. tracheiphila* infections and harsh winter temperatures, which were attractive to the citrus industry. Molecular analysis, as assessed with 11 inter-simple sequence repeats (ISSR) primers, indicated that 'Tuzcu 09 Aklimon' and its selections, 'Tuzcu 896', 'Tuzcu 897' and 'Tuzcu 898', were distinct from the other genotypes with similarity value of 0.82. Genetic variation among the other lemon genotypes was low and some of the genotypes were identical. It was concluded that variations in the agronomical characters are mainly due to mutations.

Keywords: Citrus limon; Lemon; Mal secco; ISSR

A. Uzun, O. Gulsen, G. Kafa, U. Seday, Field performance and molecular diversification of lemon selections, *Scientia Horticulturae*, Volume 120, Issue 4, 19 May 2009, Pages 473-478, ISSN 0304-4238, DOI: 10.1016/j.scienta.2008.12.003.

(<http://www.sciencedirect.com/science/article/pii/S0304423808005359>)

Abstract:

Lemon (*Citrus limon* (L.) Burm. f.) is one of the most important Citrus fruit for Turkey because of its great amount of production and export. It has been cultivated for a long time in Turkey, and therefore variations for agronomical traits are likely among cultivated lemons due to bud mutations and, hybridizations. The objectives of this study were to determine variations for some selected agronomical traits and genetic markers among 12 new lemons derived from selections. Tree growth, yield, fruit quality, and molecular diversification of these clones were determined. After four years of evaluation, 'Kutdiken' M-51 indicated the highest canopy volume. For yield per tree, the best clone was 'Kutdiken' M-51. After five years of evaluation, 'Kibris' M-54 had the highest fruit weight and acidity. 'Italian Memeli' M-56 contained

the lowest seed number and the highest total soluble solids. Molecular analysis, as assessed with 22 random amplification of polymorphic DNA (RAPD) and 11 inter simple sequence repeats (ISSR) primers, indicated that seven of twelve clones were separated with RAPD markers, whereas four were distinguished with ISSR markers. Combined analysis of RAPD and ISSR data detected that similarity values among the lemons clones were between 0.97 and 1.00. It can be concluded that variations in orchards are abundant and mainly due to mutations.

Keywords: Lemon; Cultivar development; Breeding; Clonal selection; Citrus

Martin Aluja, Mariano Ordano, Peter E.A. Teal, John Sivinski, Dario Garcia-Medel, Alberto Anzures-Dadda, Larval feeding substrate and species significantly influence the effect of a juvenile hormone analog on sexual development/performance in four tropical tephritid flies, *Journal of Insect Physiology*, Volume 55, Issue 3, March 2009, Pages 231-242, ISSN 0022-1910, DOI: 10.1016/j.jinsphys.2008.11.013.

(<http://www.sciencedirect.com/science/article/pii/S0022191008002576>)

Abstract:

The juvenile hormone (JH) analog methoprene reduces the amount of time it takes laboratory-reared *Anastrepha suspensa* (Caribbean fruit fly) males to reach sexual maturity by almost half. Here, we examined if methoprene exerted a similar effect on four other tropical *Anastrepha* species (*Anastrepha ludens*, *Anastrepha obliqua*, *Anastrepha serpentina* and *Anastrepha striata*) reared on natural hosts and exhibiting contrasting life histories. In the case of *A. ludens*, we worked with two populations that derived from *Casimiroa greggii* (ancestral host, larvae feed on seeds) and *Citrus paradisi* (exotic host, larvae feed on pulp). We found that the effects of methoprene, when they occurred, varied according to species and, in the case of *A. ludens*, according to larval host. For example, in the case of the two *A. ludens* populations the effect of methoprene on first appearance of male calling behavior and number of copulations was only apparent in flies derived from *C. greggii*. In contrast, males derived from *C. paradisi* called and mated almost twice as often and females started to lay eggs almost 1 day earlier than individuals derived from *C. greggii*, but in this case there was no significant effect of treatment (methoprene) only a significant host effect. There were also significant host and host by treatment interactions with respect to egg clutch size. *A. ludens* females derived from *C. paradisi* laid significantly more eggs per clutch and total number of eggs than females derived from *C. greggii*. With respect to the multiple species comparisons, the treatment effect was consistent for *A. ludens*, occasional in *A. serpentina* (e.g., calling by males, clutch size), and not apparent in the cases of *A. obliqua* and *A. striata*. Interestingly, with respect to clutch size, in the cases of *A. ludens* and *A. serpentina*, the treatment effect followed opposite directions: positive in the case of *A. ludens* and negative in the case of *A. serpentina*. We center our discussion on two hypotheses (differential physiology and larval-food), and also interpret our results in light of the life history differences exhibited by the different species we compared.

Keywords: Methoprene; Juvenile hormone analog; Mating behavior; Oviposition behavior; *Anastrepha*; Tephritidae

Jean A.T. Pennington, Rachel A. Fisher, Classification of fruits and vegetables, *Journal of Food Composition and Analysis*, Volume 22,

Supplement 1, 32nd National Nutrient Database Conference, December 2009, Pages S23-S31, ISSN 0889-1575, DOI: 10.1016/j.jfca.2008.11.012. (<http://www.sciencedirect.com/science/article/pii/S0889157509000192>)

Abstract:

Classifications for fruits and vegetables are most helpful for dietary assessment and guidance if they are based on the composition of these foods. This work determined whether levels of food components in fruits and vegetables correlated with classification criteria based on botanic family, color, part of plant, and total antioxidant capacity (TAC). A database of 104 commonly consumed fruits and vegetables was created that contained food components known to be provided primarily by these foods. A mathematical clustering algorithm was used to group the foods into homogeneous clusters based on food component levels and the classification criteria. Most useful in categorizing were the botanic families rose, rue (citrus), amaryllis, goosefoot, and legume; color groupings blue/black, dark green/green, orange/peach, and red/purple; and plant parts fruit-berry, seeds or pods, and leaves. Groupings based on TAC levels did not match well with the identified clusters. Clusters were often best defined by a combination of classification variables such as color and part of plant. Results suggest that the groupings dark green leafy vegetables; cabbage family vegetables; lettuces; allium family bulbs; legumes; deep orange/yellow fruits, roots, and tubers; citrus family fruits; tomatoes and other red vegetables and fruits; and red/purple/blue berries are predictive for food components provided by fruits and vegetables.

Keywords: Antioxidants; Classification; Dietary assessment; Dietary guidance; Food composition; Fruits; Phytonutrients; TAC; Total antioxidant capacity; Vegetables

ScienceDirect Jeruk 2010

Fumigant activity of volatiles of *Streptomyces globisporus* JK-1 against *Penicillium italicum* on *Citrus microcarpa*/Qili Li, Ping Ning, Lu Zheng, Junbin Huang, Guoqing Li, Tom Hsiang

Postharvest Biology and Technology, Volume 58, Issue 2, November 2010, Pages 157-165, ISSN 0925-5214, DOI: 10.1016/j.postharvbio.2010.06.003. (<http://www.sciencedirect.com/science/article/pii/S0925521410001353>)

Abstract:

Antifungal activity against *Penicillium italicum* of volatile substances from *Streptomyces globisporus* JK-1 grown on autoclaved wheat seed was studied in vitro and in planta. Fungal spore germination and mycelial growth of *P. italicum* cultures as well as sporulation and disease incidence on fungal-inoculated fruit were suppressed in the presence of the volatiles. For naturally infected fruit, disease incidence was reduced from 25% to 7.5%. Suppression of the infection process of *P. italicum* on Shatang Mandarin fruit (*Citrus microcarpa*) was observed via scanning electronic microscopy, showing inhibited spore germination on the Shatang Mandarin, and abnormal morphology for conidiophores and hyphae exposed to the volatiles. Based on gas chromatography/mass spectrophotometric analyses, 41 volatile organic compounds were identified from the volatiles of *S. globisporus* JK-1, and the most abundant compound was trans-1,10-dimethyl-trans-9-decalol (geosmin), an earthy smelling substance. Among these, technical grade formulations of

eight were chosen for further study: phenylethyl alcohol, caryophyllene, dimethyl disulfide, dimethyl trisulfide, acetophenone, d-limonene, isolekene, and aromadendrene. d-Limonene, isolekene and aromadendrene showed no observable antifungal activity in vitro and in planta at tested concentrations. Both phenylethyl alcohol and caryophyllene showed weak inhibitory activity in vitro but no significant efficacy against *P. italicum* on Shatang Mandarin. Dimethyl disulfide or dimethyl trisulfide showed antifungal activity in vitro and efficacious control on Shatang Mandarin at a concentration of 100 [μ]L L-1 of airspace in treatment containers. Acetophenone showed antifungal activity in vitro at a concentration of 100 [μ]L L-land efficacious control on Shatang Mandarin at the highest concentration of 1000 [μ]L L-1. Volatiles from *S. globisporus* JK-1 have potential for control of blue mold of citrus species through fumigant action.

Keywords: *Streptomyces globisporus* JK-1; Volatiles; *Penicillium italicum*

Grapefruit bioactive limonoids modulate *E. coli* O157:H7 TTSS and biofilm/Amit Vikram, Palmy R. Jesudhasan, G.K. Jayaprakasha, B.S. Pillai, Bhimanagouda S. Patil

International Journal of Food Microbiology, Volume 140, Issues 2-3, 15 June 2010, Pages 109-116, ISSN 0168-1605, DOI: 10.1016/j.ijfoodmicro.2010.04.012. (<http://www.sciencedirect.com/science/article/pii/S0168160510002229>)

Abstract:

Limonoids are important constituents of the grapefruit and other citrus fruits. Research on health benefits suggests that citrus limonoids may act as anti-cancer, cholesterol lowering, anti-HIV and anti-feedant compounds. However, antimicrobial activities of citrus limonoids are not reported. In the present investigation, limonoids were purified from grapefruit seed and evaluated for their potential to antagonize cell-to-cell communication, biofilm formation and expression of Enterohemorrhagic *Escherichia coli* (EHEC) type three secretion system (TTSS). The results of the present study suggest that, certain limonoids are inhibitory to the cell-to-cell communication, biofilm formation and EHEC TTSS. Specifically, obacunone demonstrated strong inhibition of EHEC biofilm formation and TTSS. Furthermore, obacunone and other limonoids seem to inhibit the biofilm formation and TTSS in quorum sensing dependent fashion. The results indicate that certain grapefruit limonoids may possibly help in antagonizing the EHEC infection process, and may serve as lead compound in development of new antipathogenic molecules.

Keywords: Limonoids; Purification; Cell-cell communication; Quantitative PCR; EHEC O157:H7

Agrobacterium tumefaciens-mediated genetic transformation and plant regeneration from a complex tetraploid hybrid citrus rootstock/M. Dutt, J. Madhavaraj, J.W. Grosser

Scientia Horticulturae, Volume 123, Issue 4, 2 February 2010, Pages 454-458, ISSN 0304-4238, DOI: 10.1016/j.scienta.2009.10.010. (<http://www.sciencedirect.com/science/article/pii/S0304423809004671>)

Abstract:

Agrobacterium-mediated genetic transformation of a tetraploid 'tetrazyg' citrus rootstock selection 'Orange #16' [Nova mandarin (*Citrus reticulata* Blanco) + Hirado Buntan pummelo (*Citrus grandis* L.

Osbeck)] x [Cleopatra mandarin (*C. reticulata* Blanco) + Argentine trifoliolate orange (*Poncirus trifoliata* (L.) Raf.)] was performed. Juvenile epicotyl segments were transformed with a construct containing a bifunctional egfp-nptII fusion gene under the control of an enhanced double CaMV 35S promoter. Our protocol resulted in a reasonable transformation efficiency of 18%. Stable integration of the transgene was confirmed by visual observation of EGFP expression, PCR and Southern blot hybridization. The purpose of this work was to investigate the amenability of novel citrus rootstock germplasm being developed for improved tree size control, soil adaptation, and disease resistance, to existing transformation technologies. Seed trees of such transgenic tetraploids also have potential as trap plants containing potent insecticidal transgenes, due to their inedible fruit and inherent crossing barriers with conventional commercial diploid scion cultivars, and could be planted around producing citrus groves.

Keywords: *Agrobacterium tumefaciens*; Bifunctional gene; Citrus; EGFP; Genetic transformation; Tetrazyg; Tetraploid

Tree performance and fruit yield and quality of 'Okitsu' Satsuma mandarin grafted on 12 rootstocks/ Tatiana Cantuarias-Aviles, Francisco de Assis Alves Mourao Filho, Eduardo Sanches Stuchi, Simone Rodrigues da Silva, Erick Espinoza-Nunez,

Scientia Horticulturae, Volume 123, Issue 3, 4 January 2010, Pages 318-322, ISSN 0304-4238, DOI: 10.1016/j.scienta.2009.09.020.

(<http://www.sciencedirect.com/science/article/pii/S0304423809004543>)

Abstract:

The citriculture in Brazil, as well as in other important regions in the world, is based on very few mandarin cultivars. This fact leads to a short harvest period and higher prices for off-season fruit. The 'Okitsu' Satsuma (*Citrus unshiu* Marc.) is among the earliest ripening mandarin cultivars, and it is considered to be tolerant to citrus canker (*Xanthomonas citri* subsp. *citri* Schaad et al.) and to citrus variegated chlorosis (*Xylella fastidiosa* Wells et al.). Despite having regular fruit quality under hot climate conditions, the early fruit maturation and absence of seeds of 'Okitsu' fruits are well suited for the local market in the summer (December through March), when the availability of citrus fruits for fresh consumption is limited. Yet, only a few studies have been conducted in Brazil on rootstocks for 'Okitsu'. Consequently, a field trial was carried out in Bebedouro, Sao Paulo State, to evaluate the horticultural performance of 'Okitsu' Satsuma mandarin budded onto 12 rootstocks: the citrandarin 'Changsha' mandarin (*Citrus reticulata* Blanco) x *Poncirus trifoliata* 'English Small'; the hybrid Rangpur lime (*Citrus limonia* Osbeck) x 'Swingle' citrumelo (*P. trifoliata* (L.) Raf. x *Citrus paradisi* Macfad.); the trifoliates (*P. trifoliata* (L.) Raf.) 'Rubidoux', 'FCAV' and 'Flying Dragon' (*P. trifoliata* var. *monstrosa*); the mandarins 'Sun Chu Sha Kat' (*C. reticulata* Blanco) and 'Sunki' (*Citrus sunki* (Hayata) Hort. ex. Tanaka); the Rangpur limes (*C. limonia* Osbeck) 'Cravo Limeira' and 'Cravo FCAV'; 'Carrizo' citrange (*Citrus sinensis* x *P. trifoliata*), 'Swingle' citrumelo (*P. trifoliata* x *C. paradisi*), and 'Orlando' tangelo (*C. paradisi* x *Citrus tangerina* cv. 'Dancy'). The experimental grove was planted in 2001, using a 6 m x 3 m spacing, in a randomized block design. No supplementary irrigation was applied. Fruit yield, canopy volume, and fruit quality were assessed for each rootstock. A cluster multivariate analysis identified three different rootstock pairs with similar effects on plant growth, yield and fruit quality of

`Okitsu' mandarin. The `Flying Dragon' trifoliolate had a unique effect over the `Okitsu' trees performance, inducing lower canopy volume and higher yield efficiency and fruit quality, and might be suitable for high-density plantings. The `Cravo Limeira' and `Cravo FCAV' Rangpur limes induced early-ripening of fruits, with low fruit quality. `Sun Chu Sha Kat' and `Sunki' mandarins and the `Orlando' tangelo conferred lower yield efficiency and less content of soluble solids for the latter rootstock.

Keywords: Canopy volume; Citrus unshiu Marc.; Fruit size and weight; Soluble solids; Titrable acidity; Yield efficiency

ScienceDirect Jeruk 2011

Seasonal effects of seed age on regeneration potential and transformation success rate in three citrus cultivars/Vladimir Orbovic, Manjul Dutt, Jude W. Grosser

Scientia Horticulturae, Volume 127, Issue 3, 10 January 2011, Pages 262-266, ISSN 0304-4238, DOI: 10.1016/j.scienta.2010.10.004.
(<http://www.sciencedirect.com/science/article/pii/S0304423810004528>)

Abstract:

The effects of seed age on shoot regeneration potential and transformation rate of `Duncan' and `Flame' grapefruit cultivars, along with `Hamlin' sweet orange cultivar were investigated. Shoot regeneration potential of all three cultivars varied throughout the season. Cumulative data for shoot regeneration of explants incubated in bacterial suspension exhibited higher values early in the season and in the first months of the spring, with significant drops during the winter months and later in the season. Transformation rate did not vary as much as shoot regeneration potential. Data describing the propensity of `Flame' and `Hamlin' tissue for genetic transformation exhibited a negative trend as the season progressed. `Duncan' transformation rate held steady during the season. Taken together, our results confirm the need for specific culturing protocols to be developed and used for different citrus cultivars at specific times to reduce variability of responses these cultivars exhibit to culturing conditions and transformation attempts.

Keywords: Citrus; Seed-age; Genetic transformation; Shoot regeneration

Biochemical profiling of mucilage extracted from seeds of different citrus rootstocks/Summar A. Naqvi, M.M. Khan, M. Shahid, M.J. Jaskani, Iqrar A. Khan, Mohammad Zuber, Khalid Mahmood Zia

Carbohydrate Polymers, Volume 83, Issue 2, 10 January 2011, Pages 623-628, ISSN 0144-8617, DOI: 10.1016/j.carbpol.2010.08.031.
(<http://www.sciencedirect.com/science/article/pii/S014486171000665X>)

Abstract:

Hetero-polysaccharide mucilage was extracted from the seed coats of different citrus rootstocks viz. Rough lemon, Sachtion citrumelo and Yuma citrange for investigating its biochemical and molecular properties. Investigations showed that the mucilage contained (mg/g) starch 3.13-5.04; maltose 3.23-4.31; glucosamine 0.017-0.289; d-xylose 0.059-0.107 and total soluble sugars 8.13-11.82. Specific enzyme activities were 16.98-35.96, 30.60-98.45, 42.00-73.98, 660.98-738.35 and 7.660-19.27 IU mg⁻¹ of protein for protease, amylase, catalase,

peroxidase and superoxide dismutase, respectively. Proximate analysis showed 12.85-13.94% moisture, 11.25-14.06% crude protein, 0.31-0.86% crude lipid, 1.31-2.69% crude fibre, 2.95-3.45% ash and 81.48-91.49 kJ 100 g⁻¹ energy. The comparative characterization of the extractable proteins was profiled by SDS-PAGE and quantified using Bradford assay. Structural properties of samples were analyzed and compared using Fourier transformation infrared (FT-IR) spectroscopy.

Keywords: Citrus; Rootstocks; Seed; Mucilage; Polysaccharides

Characterisation of citrus rootstock germplasm introduced as seeds to Australia from the People's Republic of China/S.R. Sykes

Scientia Horticulturae, Volume 127, Issue 3, 10 January 2011, Pages 298-304, ISSN 0304-4238, DOI: 10.1016/j.scienta.2010.10.015.

(<http://www.sciencedirect.com/science/article/pii/S0304423810004796>)

Abstract:

Seeds were collected from a range of citrus rootstock types in China and sent to Australia for evaluation. Before evaluation proceeded, however, the seeds and their seedlings were characterised for uniformity and trueness-to-type. The seeds were cultured in vitro and/or germinated in sand beds to assess whether or not they were mono- or polyembryonic. Seedlings were then rogued on the basis of vigour and morphology before isozyme profiles were developed from leaf extracts to assess seedling uniformity within introductions. Isozyme profiles were also compared to those of the source trees, as well as hybrids generated between some of them in China, to assess and verify trueness-to-type. The degree of variability between the seedlings propagated from the imported seeds and their source trees in China differed between accessions, which highlighted some of the issues that need to be considered when importing citrus germplasm as seeds. Regardless of whether the seedlings could be shown to be identical to their source tree in China, three uniform seedlings of polyembryonic types were established in arboreta as Australian source trees to provide propagules for evaluation and possibly commercial use.

Keywords: Citrus; Poncirus; Introduction; Seedling uniformity; Isozymes

Elucidation of the flavonoid and furocoumarin composition and radical-scavenging activity of green and ripe chinotto (*Citrus myrtifolia* Raf.) fruit tissues, leaves and seeds/Davide Barreca, Ersilia Bellocco, Corrado Caristi, Ugo Leuzzi, Giuseppe Gattuso

Food Chemistry, Volume 129, Issue 4, 15 December 2011, Pages 1504-1512, ISSN 0308-8146, DOI: 10.1016/j.foodchem.2011.05.130.

(<http://www.sciencedirect.com/science/article/pii/S0308814611008338>)

Abstract:

Citrus myrtifolia Raf. (chinotto) flavedo, albedo and carpel membranes from green and ripe fruits, as well as seeds and leaves, were investigated for the first time for their flavonoid and furocoumarin composition. Twenty-three unique compounds distributed in the different fruit/plant parts were identified and quantified. All samples analysed contained flavanone O-glycosides, flavone C- and O-glycosides and furocoumarins; flavedos and albedos also contained significant amounts of polymethoxyflavones. Flavedo and albedo extracts were found to be richest in flavonoids and furocoumarins, containing up to 1.95 g/kg fresh weight. Flavedo, albedo and carpel membranes from ripe fruits were found to be richer than the corresponding tissues from unripe fruits. The remarkable radical-scavenging activity of all the extracts

was tested by DPPH-, ABTS+ and FRAP methods, revealing that (i) they were particularly efficient in quenching ABTS+ radical cations (up to 9.8 mM Trolox equivalents), and (ii) flavedo and albedo extracts, on average, showed the highest antioxidant capacity.

Keywords: Citrus myrtifolia Raf.; HPLC-DAD-ESI-MS/MS; Flavonoids; Furocoumarins; Antioxidant activity

Characterization of genomic sequence showing strong association with polyembryony among diverse Citrus species and cultivars, and its synteny with Vitis and Populus/Michiharu Nakano, Takehiko Shimada, Tomoko Endo, Hiroshi Fujii, Hirohisa Nesumi, Masayuki Kita, Masumi Ebina, Tokurou Shimizu, Mitsuo Omura,

Plant Science, In Press, Accepted Manuscript, Available online 17 August 2011, ISSN 0168-9452, DOI: 10.1016/j.plantsci.2011.08.002. (<http://www.sciencedirect.com/science/article/pii/S0168945211002238>)

Abstract:

Polyembryony, in which multiple somatic nucellar cell-derived embryos develop in addition to the zygotic embryo in a seed, is common in the genus Citrus. Previous genetic studies indicated polyembryony is mainly determined by a single locus, but the underlying molecular mechanism is still unclear. As a step towards identification and characterization of the gene or genes responsible for nucellar embryogenesis in Citrus, haplotype-specific physical maps around the polyembryony locus were constructed. By sequencing three BAC clones aligned on the polyembryony haplotype, a single contiguous draft sequence consisting of 380 kb containing 70 predicted open reading frames (ORFs) was reconstructed. Single nucleotide polymorphism genotypes detected in the sequenced genomic region showed strong association with embryo type in Citrus, indicating a common polyembryony locus is shared among widely diverse Citrus cultivars and species. The arrangement of the predicted ORFs in the characterized genomic region showed high collinearity to the genomic sequence of chromosome 4 of Vitis vinifera and linkage group VI of Populus trichocarpa, suggesting that the syntenic relationship among these species is conserved even though V. vinifera and P. trichocarpa are non-apomictic species. This is the first study to characterize in detail the genomic structure of an apomixis locus determining adventitious embryony.

Keywords: Citrus, Apomixis, Polyembryony, Synteny, Haplotype

Chemical composition and biological activity of Citrus jambhiri Lush/Dalia Hamdan, Mahmoud ZakiEl-Readi, Ahmad Tahrani, Florian Herrmann, Dorothea Kaufmann, Nawal Farrag, Assem El-Shazly, Michael Wink

Food Chemistry, Volume 127, Issue 2, 15 July 2011, Pages 394-403, ISSN 0308-8146, DOI: 10.1016/j.foodchem.2010.12.129.

(<http://www.sciencedirect.com/science/article/pii/S030881461100032X>)

Abstract:

The fresh peel of Citrus jambhiri was extracted with aqueous methanol and the residue was fractionated using light petroleum, chloroform and ethyl acetate. The constituents of the extracts were separated by column chromatography employing solvents of different polarity. The chemical structure of the isolated compounds was then identified by MS and NMR. Column chromatography of the petroleum fraction resulted in the isolation of nobiletin, 5-O-demethylnobiletin, tangeretin, 5-hydroxy-3,6,7,8,3',4'-hexamethoxyflavone, 3,5,6,7,8,3',4'-heptamethoxyflavone, and a mixture of [beta]-sitosterol and

stigmasterol. The chloroform fraction afforded 6-demethoxynobiletin, 5,4'-dihydroxy-6,7,8,3'-tetramethoxyflavone, limonin and nomilin. The flavonoid glycosides naringin, hesperidin and neohesperidin were isolated from the ethyl acetate fraction. The chemical structure of the isolated compounds was established by MS and NMR (APT, COSY, HSQC, HMBC, and NOESY). LC-ESI-MS analysis of the ethyl acetate fraction afforded eight flavonoid glycosides, while the dichloromethane fraction of the defatted seeds contained seven limonoid aglycones. The chloroform fraction exerted the strongest DPPH* free radical scavenging activity in comparison to other fractions. The petroleum fraction showed a significant inhibition of lipoxygenase indicating an anti-inflammatory action (IC₅₀ 29 +/- 1 [μg/mL]). Some of the isolated polymethoxyflavones exhibited strong cytotoxicity against COS7, HeLa and Caco-2 cell lines.

Keywords: Citrus jambhiri; Polymethoxyflavones; Flavonoid glycosides; Limonoids; NMR; LC-ESI/MS; Antioxidant; Anti-inflammatory; Cytotoxicity

Valorization of citrus by-products using Microwave Steam Distillation (MSD)/Naima Sahraoui, Maryline Abert Vian, Mohamed El Maataoui, Chahrazed Boutekdjiret, Farid Chemat

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(<http://www.sciencedirect.com/science/article/pii/S1466856411000270>)

Abstract:

A microwave steam distillation (MSD) of essential oils from fresh citrus by-products (orange peels) was studied. The effectiveness of this innovative method in extraction of citrus essential oils have been evaluated and compared to conventional steam distillation. MSD offers important advantages like shorter extraction time (6 min), cleaner features and provides an essential oil with better sensory properties (better reproduction of natural fresh fruit aroma of the citrus essential oil) at optimized power (500 W). Results from chemical and cytological approaches confirm the effectiveness of this new technique, that allows substantial savings in terms of time and energy. Industrial relevance

The treatment of by-products represents a strong demand for industrial fruits processing, which produces tonnages of waste material such as peels, seeds and fibers. The disposal of these materials usually represents an industrial legal restriction problem. Moreover, the waste treatment represents significant costs and is often misjudged by companies. Transformation of waste products with high value-added allows companies to reduce the global treatment costs, sometimes even to take some profits and thus improve their competitiveness. Moreover, the recovery process of by-products is part of the current existing sustainable development and environmental protection.

Keywords: Microwave; Steam distillation; By-product; Essential oil; Citrus

Assessing the biological control potential of an adventitiously-established 'pest', *Scirtothrips aurantii* (Faure), on a weed, *Bryophyllum delagoense* (Eckl. & Zeyh.), in Queensland/M.A. Rafter, W.A. Palmer, G.H. Walter

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(<http://www.sciencedirect.com/science/article/pii/S1049964411001198>)

Abstract:

South African citrus thrips (*Scirtothrips aurantii*) established adventitiously in Australia. Although it is a major horticultural pest in Africa, it is now advocated as a possible biological control agent against *Bryophyllum delagoense* Eckl. & Zeyh. (Crassulaceae). To evaluate the biocontrol potential of *S. aurantii* a two year field study was conducted on the western Darling Downs of southern Queensland. Imidacloprid insecticide was applied to two quadrats at each of 18 field sites to assess, in the absence of *S. aurantii*, the persistence of individual plants and to quantify propagule production and recruitment by this declared weed. A third quadrat was left, as a control, to be infested naturally by *S. aurantii*. When released from herbivory by thrips in the field, plants grew significantly more, flowered more, and were significantly more fecund than plants in the quadrats with *S. aurantii*. Increases in growth and fecundity translated into significantly increased plant numbers but not increased recruitment. Recruitment even declined in experimental quadrats, through the indirect effects of releasing plants from herbivory. Field sampling also revealed that *S. aurantii* may be sensitive to seasonal climatic fluctuations. These and other local climatic influences may limit the biological control potential of the insect.

Keywords: Insecticide exclusion study; Mother-of-millions; South African citrus thrips; Biocontrol potential

Effect of natural antioxidants on the lipid oxidation of microencapsulated seed oil/Jang-Hyuk Ahn, Young-Pil Kim, Hak-Sung Kim, **Food Control**, In Press, Accepted Manuscript, Available online 19 August 2011, ISSN 0956-7135, DOI: 10.1016/j.foodcont.2011.08.026.
(<http://www.sciencedirect.com/science/article/pii/S0956713511003343>)

Abstract:

Lipid oxidation was effectively prevented by natural antioxidants (NA) for surface free and encapsulated oils in microencapsulated seed oil (MESO) coated with dextrin and milk protein. Three kinds of NA were extracted from rosemary, broccoli sprout, and citrus, respectively. The antioxidant effect was significantly enhanced by the use of a mixture composed of 0.05% (w/w, oil based) rosemary, 1% broccoli sprout, and 1% citrus extract. The peroxide value (POV) of the total oil in the MESO was shown to lower to about 60 meq/kg even under the accelerated storage condition at 60 for 30 days. The POV of total oil from MESO was 28.1 meq/kg in the presence of antioxidants, whereas the POV of the control sample without antioxidants reached 78.8 meq/kg. The present approach can find widespread use for preventing various microencapsulated seed oils from lipid oxidation.

Keywords: Natural antioxidant; Microencapsulation; Sunflower oil; Lipid oxidation; Peroxide value