InHort
INSTYTUT OGRODNICTWA

4th International Conference

"Effects of Pre- and Post-harvest Factors on Health Promoting Components and Quality of Horticultural Commodities"

June 16-18, 2019

Skierniewice, Poland

BOOK OF ABSTRACTS

Ogranized by Research Institute of Horticulture

euvrin European Vegetable Research Institutes Network

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EFM European Fruit Magazine

Polish Society for Horticultural Science

4th International Conference

"Effects of Pre- and Post-harvest Factors on Health Promoting Components and Quality of Horticultural Commodities"

June 16-18, 2019, Skierniewice, Poland

Organized by **Research Institute of Horticulture**

in cooperation with

- EUFRIN – Postharvest and Fruit Quality Working Group
- EUVRIN – Postharvest and Vegetable Quality Working Group

under the auspices of

- Polish Society for Horticultural Sciences (PSHS)

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- European Fruit Magazine (EFM)

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Note

The abstracts were not edited for the scientific and linguistic merit by the Organizing Committee of the Conference and accepted for printing "as is". Only minor editorial corrections were applied where necessary.

Program of the 4th International Conference

"Effects of Pre- and Post-harvest Factors on Health Promoting Components and Quality of Horticultural Commodities"

Sunday 16th of June 2019

19:00	Welcome Reception (with sightseeing of the Palace) Palace of the Research Institute of Horticulture (InHort), Konstytucji 3 Maja 1/3 Str.

Monday 17th of June 2019

Main building of the Pomology Division of InHort, Pomologiczna 18 Str.

7:30 – 8:40		Registration of Conference participants and Poster hanging
8:40 – 9:20		Opening Ceremony of the Conference **Krzysztof Rutkowski** – Chairman of the Conference **Dorota Konopacka** – Director of the Research Institute of Horticulture **Dirk Köpcke** – Chairman of the EUFRIN Postharvest and Fruit Quality Working Group **Ann Schenk** – Chairman of the EUVRIN Postharvest and Vegetables Quality Working Group
9:20 – 10:50		**Session I – Chairman: Krzysztof Rutkowski** (Poland)
9:20 – 10:10	1.	**Joanna Kolniak-Ostek** (Poland) – Invited Speaker Phenolic compounds and their function in plants and human organism
10:10 – 10:30	2.	**Ernst J. Woltering** (The Netherlands) Pre- and postharvest lighting strategies to improve nutritional quality and shelflife of fruit and vegetables
10:30 – 10:50	3.	**Kalina Sikorska-Zimny** (Poland) The pre- and postharvest factors influence glucosinolates content in plants
10:50 – 11:10		**Coffee break**
11:10 – 12:50		**Session II – Chairman: Angelo Zanella** (Italy)
11:10 – 11:30	4.	**Remigijus Daubaras** (Lithuania) Evaluation of biochemical processes in the American cranberries during storage
11:30 – 11:50	5.	**Pablo Fernández Cancelo** (Spain) Influence of the growing location and the maturity at harvest on the composition, physiology and storage potential of 'Golden Reinders' apples.
11:50 – 12:10	6.	**Anna Wrzodak** (Poland) Effect of 1-methylcyclopropene treatment and stage of maturity on nutritional quality of tomato fruit (*Solanum esculentum* L.) during storage
12:10 – 12:30	7.	**Monika Mieszczakowska-Frąc** (Poland) Red-fleshed apple – fruit for processing
12:30 – 12:50	8.	**Ingrid Aguiló-Aguayo** (Spain) AGRIMAX Project: Developing and demonstrating the production of multiple, high-value products from crop and Food–processing waste
13:00 – 14:00		**Lunch** ("Finezja" Restaurant, Sienkiewicza 2 Str. – walking distance)

14:00 – 18:30		**Professional Tour** - visiting blueberry plantation, ca 20 ha, with a newly erected cold storage facility for blueberries (50 tonnes capacity), with forced air cooling system - **Doleck**; - visiting cold storage facility, ca 12 000 tonnes capacity, belonging to FRUIT FAMILY dynamically growing producer group - **Sadków Szlachecki**
19:00 – 22:00		**Conference Dinner** "Stara Wozownia" Restaurant, Mała Wieś 40, 05-622 Belsk Duży – https://palacmalawies.pl/en/lang
22:30		**Bus transfer to Skierniewice (ca 1 hour trip)**

Tuesday 18th of June 2019

Main building of the Pomology Division of InHort, Pomologiczna 18 Str.

8:00 – 9:00		**Poster viewing and coffee service**
9:00 – 10:40		**Session III – Chairman: Dirk Köpcke** (Germany)
9:00 – 9:40	9.	**Angelo Zanella** (Italy) **Invited speaker** Collaborative efforts for determining and predicting postharvest apple fruit quality
9:40 – 10:00	10.	**Krzysztof P. Rutkowski** (Poland) Response of 'Ligol' and 'Red Jonaprince' apple cvs to DCA CF storage
10:00 – 10:20	11.	**Maria Grzegorzewska** (Poland) Dynamic Controlled Atmosphere (DCA CF) in vegetable storage
10:20 – 10:40	12.	**Anna Skorupińska** (Poland) Storage and Fruit Quality of selected cultivars of Asian Pears
10:40 – 11:00		**Coffee break**
11:00 – 11:30		**Session IV – Summary of the Poster Session** **Chairman: Dominikus Kittemann** (Germany)
11:30 – 12:50		**Session V – Chairman: Ann Schenk** (Belgium)
11:30 – 11:50	13.	**Clara Puig Pons** (Spain) Preharvest conditions affect the fruit quality of long shelf life tomato varieties
11:50 – 12:10	14.	**Gemma Echeverria** (Spain) Postharvest strategies to preserve quality of fresh and processed calot (*Allium cepa* L.)
12:10 – 12:30	15.	**Rungsinee Sothornvit** (Thailand) Active glucomannan coating to prolong the quality of banana
12:30 – 12:50	16.	**Maria B. Pérez-Gago** (Spain) Hydroxypropyl methylcellulose–based edible coatings formulated with antifungal food additives to reduce alternaria black spot and maintain postharvest quality of cold-stored 'Rojo Brillante' persimmons
13:00 – 14:00		**Lunch** ("Finezja" Restaurant, Sienkiewicza 2 Str. - walking distance)

14:00 – 14:40		**Session VI – Chairman: Franciszek Adamicki** (Poland)
14:00 – 14:20	17.	**Martin Geyer** (Germany) Airflow distribution and management in an apple storage room
14:20 – 14:40	18.	**Zbigniew Jóźwiak** (Poland) An attempt to measure temperature distribution across a glycol type, fin coil air cooling unit – a practical approach
14:40 – 15:00		**Discussion and Closing Ceremony of the Conference** Main building of the Pomology Division of InHort, Pomologiczna 18 Str.
15:00 – 15:30		**Coffee break**
15:30 – TBA		**EUFRIN/EUVRIN meeting** Main building of the Pomology Division of InHort, Pomologiczna 18 Str.

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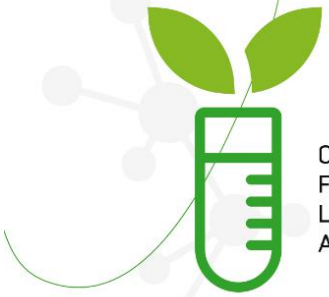

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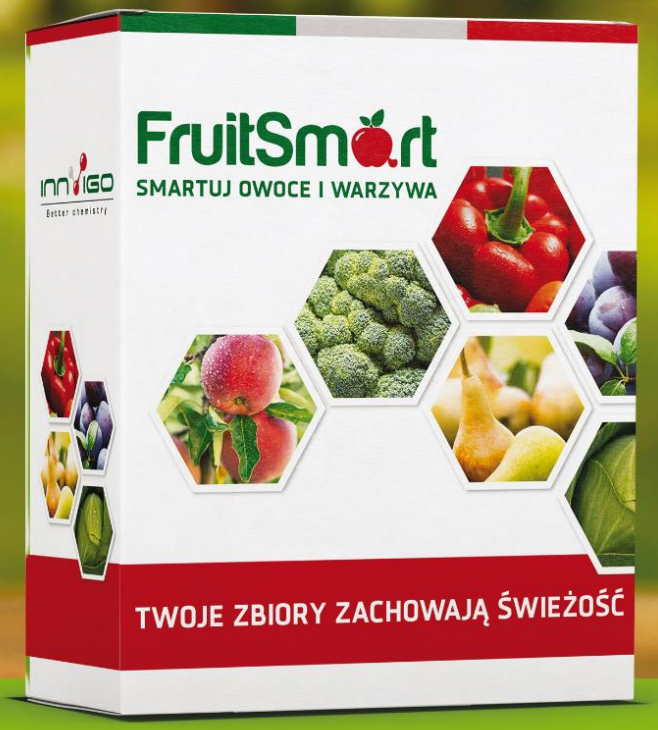

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ABSTRACTS OF POSTERS

4th International Conference

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June 16-18, 2019, Skierniewice, Poland

ABSTRACTS OF ORAL PRESENTATIONS

PHENOLIC COMPOUNDS AND THEIR FUNCTION IN PLANTS AND HUMAN ORGANISM

Joanna Kolniak-Ostek

Wroclaw University of Environmental and Life Sciences, Department of Fruit, Vegetable and Plant Nutraceuticals Technology, Chełmońskiego 37 Street, 51-630 Wrocław, Poland
e-mail: joanna.kolniak-ostek@upwr.edu.pl

Phenolic compounds are a heterogeneous group of plant secondary metabolites necessary for their growth. Due to the diversity of chemical structures, polyphenols can be divided into phenolic acids (hydroxycinnamic, hydroxybenzoic) and flavonoids. Flavonoids are more common polyphenolic structures in plants and are i.e. responsible for the colour of the fall foliage and flowers. Based on their chemical structure, flavonoids are classified into anthocyanins, flavanols, flavonols, isoflavones, flavones and flavanones. Hydroxyls in flavonoids molecules are responsible for their antioxidant activity, which is considered one of the required properties of drugs for treating such diseases as cancer, atherosclerosis, hypertension, infarct, etc. Flavonoids have a variety of effects on the human organism. They exhibit capillary strengthening, antioxidant, antiradiation, antitumor, anti-inflammatory, antiatherosclerotic, spasmolytic, hypotensive, estrogenic, and bactericidal activities. The main property of these compounds is their low toxicity and more often the lack of it.
The phenolic compounds are commonly found in both edible and inedible plant parts, including roots, stems, leaves and fruit (in the peel, pulp and seeds) and are associated with resistance to pathogens in the environment. In addition to their role in attracting pollinators and UV protection, polyphenols affect the taste and shaping the attractiveness of ripe fruit for herbivores.
Polyphenols are considered very valuable compounds due to their participation in the processes of adaptation and recovery. Their health benefits are due to the antioxidative and anti-inflammatory action.

Key words: polyphenolics, flavonoids, antioxidant activity, bioactive compounds, health benefits

POSTHARVEST LIGHTING IMPROVES NUTRITIONAL QUALITY AND SHELF LIFE OF FRUIT AND VEGETABLES

Ernst J. Woltering[1,2], Rob Schouten[2], Nikolaos Ntagkas[2], Celine C.S. Nicole[3], Leo F. M. Marcelis[2]

[1] Wageningen Food and Biobased Research, P.O. Box 17, 6700 AA Wageningen, The Netherlands
[2] Horticulture and Product Physiology Group, Wageningen University, P.O. Box 16, 6700 AA Wageningen, The Netherlands
[3] Signify Research, High Tech Campus 7, 5656 AE Eindhoven, The Netherlands
e-mail: ernst.woltering@wur.nl

Vitamin C (L-ascorbate) is an essential dietary nutrient. Vitamin C functions in enzyme activation, oxidative stress reduction, and immune function. There is evidence that vitamin C protects against respiratory tract infections and reduces risk for cardiovascular disease and some cancers. Humans and certain other vertebrates lack the enzyme L-glucono-gamma lactone oxidase required for *in vivo* synthesis of vitamin C, hence, they must acquire it from natural sources such as fruit and vegetables. Light is the major regulatory factor for Vitamin C synthesis in plants. To improve the nutritional quality of harvested products, storage under light may be considered. Green tomato fruit accumulated vitamin C when exposed to white LED light between 200 and 500 µmol m^{-2} s^{-1} compared to storage in darkness. Similar results were obtained when fruit were held under monochromatic red, blue or green LED light. In (fresh-cut) lettuce, vitamin C content rapidly decreases during storage in darkness. When stored under white LED light between 5 and 20 µmol m^{-2} s^{-1} vitamin C is largely preserved. In addition, under light, there is accumulation of sugars and the shelf life is considerably increased. Similar results were obtained when lettuce was held under monochromatic red, blue or green LED light. Inhibition of photosynthesis by DCMU alleviated the effect of light on vitamin C and sugar accumulation in lettuce. In tomato, light exposure did not affect vitamin C content once the fruit had turned red, likely because no chlorophyll was left. The effect of light on vitamin C levels in both tomato and lettuce showed a good correlation with the products photosynthetic activity. Results show that in different product categories, postharvest lighting may be applied as a non-chemical treatment to improve nutritional quality.

Key words: LED light, Vitamin C, sugar, lettuce, tomato

THE PRE- AND POSTHARVEST FACTORS INFLUENCE GLUCOSINOLATES CONTENT IN PLANTS

Kalina Sikorska-Zimny[1, 2]

[1] Fruit and Vegetables Storage and Processing Department, Research Institute of Horticulture, Konstytucji 3 Maja 1/3, 96-100 Skierniewice, Poland
[2] Institute of Heath Science, Faculty of Natural and Technical Sciences, State College of Applied Sciences in Skierniewice, Poland
e-mail: kalina.sikorska@op.pl

Glucosinolates are secondary metabolites in plant and were found in 15 botanical families of the order of *Brassicales*. Over 120 different GLSs were determined in *Brassicae*. The GLS synthesis consists of the chain-elongation of an amino acids' precursor and the aliphatic/aromatic groups, conversion of the oxime into the GSL structure (synthesis of the indolic group GLS omit the chain-elongation stage) and (dependently from final compound) alkylation, elimination, esterification or oxidation of the aliphatic/indolic groups).
The GLS content and quality depends on many factors that shape GLS during plant growth as well as after harvest.
To pre-harvest factor can be included:

- plant species,
- variety,
- cultivation condition,
- location in a plant part,
- year of cultivation,
- herbivory,
- stress.

As the postharvest factors can be point:

- storage (temperature, moisture, pH, packaging),
- cutting,
- processing (boiling and blanching, steaming, microwave usage, frying, freezing).

Each of such a factor influences GLS content in plants. Not appropriate handling can lead to decrease glucosinolates level in plant, therefore to maintain the highest quality of vegetables, the detailed examination (knowledge) over the influence of pre and postharvest factors on GLS content is crucial.

Key words: glucosinolates, metabolites, pathways, human body

EVALUATION OF BIOCHEMICAL PROCESSES IN THE AMERICAN CRANBERRIES DURING STORAGE

Remigijus Daubaras, Laima Česonienė

Vytautas Magnus University, K. Donelaičio 58, Kaunas 44248, Lithuania
e-mail: remigijus.daubaras@vdu.lt

Refrigeration is recommended for storage of most perishable fresh products. Low temperature inhibits microbial growth, retards spoilage, and suppresses undesirable metabolic changes, therefore, maintains quality and extends storage life. Most berry are chilling tolerant and can be stored at -0.5 to 0°C or slightly above their freezing points to maintain their quality. Cranberries are a particularly rich source of vitamins, phenolic phytochemicals, including phenolic acids (benzoic, hydroxycinnamic, and ellagic) and flavonoids, and, unfortunately, are known to be chilling sensitive and can develop low temperature breakdown after prolonged exposure to chilling temperatures.
Eight cultivars of American cranberry (*Vaccinium macrocarpon* Aiton) were stored at four different temperatures (0, 5, 10, and 15°C) and were evaluated for weight losses, decay, chilling injury, sugars, organic acids, fatty acids, total anthocyanins, total phenolics, antioxidant capacity, and individual flavonoids after 3 or 4 months of storage. The research data indicate that at the beginning of storage berries of cranberries preserve their marketable properties and weight losses are incurred mainly by the water evaporation, metabolism and transpiration. Later the number of unmarketable berries and storage losses increase rapidly.
'Ben Lear', 'Early Black' and 'Stevens' showed severe symptoms of chilling injury and decay at the end of 3- or 4-months storage at 0°C. 'Crowley', 'Howes' and 'Pilgrim' were relatively resistant to chilling injury and decay, while 'Franklin' and 'Wilcox' were moderately susceptible. Storage temperatures affected content of glucose, fructose, sucrose, starch, citric acid, nialic acid, and quinic acid. Storage at 5°C was found to be the optimum holding temperature with the least chilling injury symptom and decay for all cranberry cultivars evaluated.

Key words: american cranberry, storage, temperature, changes, chemical compounds

INFLUENCE OF THE GROWING LOCATION AND THE MATURITY AT HARVEST ON THE COMPOSITION, PHYSIOLOGY AND STORAGE POTENTIAL OF 'GOLDEN REINDERS' APPLES

Pablo Fernández-Cancelo, Neux Teixidó, Gemma Echeverria, C. Larrigaudière, J. Giné-Bordonaba

IRTA, XArTA-Postharharvest, Edifici Fruitcentre, PCiTAL, 25003, Lleida, Spain
e-mail: jordi.gine@irta.cat

Apple production in Spain has declined over the past decades due, in part, to the fact that more than half of all the Spanish apple production area is located within the Ebro Valley, an area characterized by dry and hot climates that detrimentally affect the final apple quality and storage potential. In this study, we therefore investigated the influence of the growing location and the fruit maturity at harvest in the overall apple quality. Accordingly, 'Golden Reinders' apples were harvested from four locations (two from valley and two from mountain) at the Optimal Harvest Date (OHD) and from the same orchard at six different maturity states (OHD-7, OHD, OHD+7, OHD+14, OHD+21, OHD+28). Quality parameters (colour, firmness, IAD, soluble solids content, titratable acidity) and a range of biochemical determinations (vitamin C, phenolic compounds, sugars and major organic acids, emitted volatiles, etc.) were quantified at harvest and after 4 months of cold storage (0°C and 95% RH) plus 7 days of shelf-life at 20°C.
Our data reveals that maturity differences within the same location mainly affect quality parameters (i.e. firmness values and starch index) and the fruit physiological characteristics (ethylene metabolism) while the location of the orchard (valley versus mountain) in fruit harvested at the optimal maturity clearly lead to a different health and taste-related composition of the fruit. For instance, at the time of optimal harvest, higher concentration of antioxidants such as ascorbate and phenolic compounds were found in mountain apples. Overall, the results from this study are discussed in the context of obtaining fruit with increased levels of health-related compounds and superior quality and storability.

Key words: antioxidants, fruit quality, location, maturity, postharvest storage

EFFECT OF 1-METHYLCYCLOPROPENE TREATMENT AND STAGE OF MATURITY ON NUTRITIONAL QUALITY OF TOMATO FRUIT (*SOLANUM ESCULENTUM* L.) DURING STORAGE

Anna Wrzodak[1], Marek Gajewski[2]

[1] Research Institute of Horticulture, Konstytucji 3 Maja 1/3, Skierniewice, Poland
[2] Warsaw University of Life Sciences (SGGW), Poland
e-mail: anna.wrzodak@inhort.pl

Experiments on the influence of 1-methylcyclopropene (1-MCP) on the quality of tomato fruit were conducted. Tomato fruits of two cv. Faustine F1 and Habana F1 (LSL – long shelf life) of greenhouse tomatoes grown in field condition and harvested at two stage of maturity (mature green and full-red) were treated with or without 1.0 µl·L^{-1} or 2.0 µl·L^{-1} of 1-MCP for 21 hours at 20°C before storage for 4 weeks 12.5°C or 20°C and 85-90% RH. Lycopene, phenolics and vitamin C contents before and after storage of tomato fruit were analyzed.
The effect of 1-MCP on lycopene, vitamin C and phenolics contents was significant and dependent on 1-MCP treatment and storage temperature. After 4 weeks of storage at both temperatures significant differences in content of lycopene for both cv. of tomatoes among 1-MCP treatments and stage of maturity as well as storage were observed. The highest content of lycopene (cv. 'Faustine' F1 3.6 mg·100 g^{-1}) and vitamin C (cv. 'Habana' F1 24.7 mg·100 g^{-1}) was found in tomatoes harvested at full-red and treated with 1-MCP. Storage of tomato fruits harvested at both stage of maturity at temperature 12.5°C and treated with 1-MCP significantly delayed the accumulation of lycopene and vitamin C. In case of phenolics content in the fruits consistent significant effects of 1-MCP treatment, stage of maturity and storage temperature as well as interaction between those factors were found. The highest content of phenolics (cv. 'Habana' F1 57.3 mg·100 g^{-1}) in full-red fruits treated with higher concentration of 1-MCP and than storage at 20°C was observed.

Key words: tomato, lycopene, vitamin C and phenolics, storage temperature,

RED-FLESHED APPLE – FRUIT FOR PROCESSING

Monika Mieszczakowska-Frąc

Research Institute of Horticulture, Department of Storage and Processing of Fruit and Vegetables, Konstytucji 3 Maja 1/3, Skierniewice, Poland
e-mail: monika.mieszczakowska@inhort.pl

Apple is a very popular fruit all over the world, constantly enjoying the recognition and trust of consumers. In recent years apple cultivars, containing anthocyanins in the flesh, in contrast to traditional apples, have become novelty on the European market.
The aim of the research was to determine the suitability for processing of the apple of selected red-fleshed cultivars as raw material for the production of juices, purees and smoothies with a natural red color obtained without the addition of coloring substances.
The study was conducted on four cultivars of red-fleshed apples: 'Trinity', 'Alex Red', 'Maypole' and 'Roxana' and two cultivars with light flesh: 'Idared' and 'Shampion', which are control cultivars. The apples were obtained from the Experimental Station of the Institute of Horticulture in Brzezna.
The results obtained in the experiments showed a high processing potential of apple cultivars with a red colour of the flesh. It was found that red-fleshed apples are a rich source of phenolic compounds. It has been confirmed that products obtained from red-fleshed apples due to the high content of malic acid are not sensory-acceptable, but can be a valuable component for the manufacturing of innovative processed products. The addition of cloudy juice or puree obtained from red-fleshed apples to products processed from traditional apples (white-fleshed) cultivars allowed obtaining an attractive in appearance and flavour products (due to the possibility of balancing sweet and sour taste) and higher in pro-health components.
The products from the 'Trinity' and 'Alex Red' cultivars can be treated as a component that gives an attractive colour, while products from the 'Roxana' cultivar may be considered a good source of pro-health ingredients.

Key words: 'Trinity', 'Alex Red', 'Maypole', 'Roxana', juices, purees, smoothies

AGRIMAX PROJECT: DEVELOPING AND DEMONSTRATING THE PRODUCTION OF MULTIPLE, HIGH-VALUE PRODUCTS FROM CROP AND FOOD-PROCESSING WASTE

Ingrid Aguiló-Aguayo, Gemma Echeverria

Institute of Agrifood Research (IRTA), XaRTA-Postharvest, Parc Científic i Tecnològic Agroalimentari de Lleida, Parc de Gardeny, Edifici Fruitcentre, 25003, Lleida, Spain
e-mail: Ingrid.Aguilo@irta.cat

AGRIMAX is an EU-funded project that is developing and demonstrating the production of multiple, high-value products from crop and food-processing waste. AGRIMAX will develop two pilot processing plants and use them to demonstrate the technical and commercial feasibility of extracting high-value compounds from agricultural and food processing waste. By applying them sequentially, AGRIMAX will produce a cascade of bio-based compounds with high-value applications, such as: agricultural materials (biodegradable pots, mulching films, bio-fertilisers); packaging (bio-polymers, bio-composites, bio-based coatings, active packaging, stabilising agents) and food (additives, ingredients, natural flavourings, edible coatings, microbial growth media). IRTA is participating in the validation part of the obtained by-products as food ingredient/additive and as a raw material for commercial microbial growth media. AGRIMAX Project has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No. 720719.

Key words: bio-based compounds, by-products

COLLABORATIVE EFFORTS FOR DETERMINING AND PREDICTING POSTHARVEST APPLE FRUIT QUALITY

Angelo Zanella, N. Sadar, P. Robatscher, W. Saeys, R.E. Schouten, P.Tijskens, L. Spinelli, M. Vanoli, P. Verboven

Research Centre Laimburg, Ora (BZ), Italy
e-mail: angelo.zanella@laimburg.it

As the apple fruit industry faces relevant post-harvest losses due to inferior quality traits of only a small part of it, current research endeavour aims to develop effective processes for the measurement and the prediction of apple fruit quality and assessment of storage potential. Herewith, solutions were sought in a multidisciplinary approach. Apple cultivars Nicoter (Kanzi®), Braeburn and Gala originating from different altitudes, European production regions, and agronomic treatments, were assessed with several non-destructive optical and acoustic techniques. Fruit were analyzed with non-destructive sensors based either on VIS interactance, chlorophyll fluorescence or acoustic firmness. Using statistics, such as probelation, kinetic models for describing post-harvest quality evolution were calibrated with promising results. Furthermore, spatially- (SRS) and time-resolved NIR spectroscopy (TRS) used for developing models describing and predicting pulp firmness, revealed relevant differences between cultivars, and the origin. In order to evaluate the potential of computer tomography (CT) regarding non-destructive assessment of internal blemishes, different settings for 2D and 3D X-ray CT were tested. While simple radiography did'nt perform satisfactorily, the CT allowed monitoring of the spatial development of internal defects and microstructure of whole fruits in the time. Furthermore, whole apples were analysed with NIR spectroscopy and compared to the standard wet analytics with the aid of HPLC-DAD and UV/VIS. The results of this research could lead to further improvement of pre- and post-harvest management of apple fruit quality.

Key words: fruit quality, non-destructive techniques, Spectroscopy, X-ray, kinetic modelling

RESPONSE OF 'LIGOL' AND 'RED JONAPRINCE' APPLE CVS TO DCA CF STORAGE

Krzysztof P. Rutkowski, Anna Skorupińska, Aneta Matulska, Zbigniew B. Jóźwiak, Karolina Celejewska, Anna Ciecierska, Monika Mieszczakowska-Frąc

Department of Fruit and Vegetable Storage and Processing, Research Institute of Horticulture, Konstytucji 3 Maja 1/3 str., Skierniewice, Poland
e-mail: krzysztof.rutkowski@inhort.pl

In the three successive storage seasons, 2015/2016, 2016/2017 and 2017/2018 for 'Ligol' cv, and in the 2018/2019 season for 'Red Jonaprince' cv, the influence of harvest date and storage technology on apple quality and storability were examined. Each year fruits were harvested twice. Fruit treated with 1-methylcyclopropene (1-MCP, SmartFresh ProTabs) and untreated (control) were stored at 1 °C and 3 °C. The following storage technologies were used: regular air (RA) and controlled atmosphere (CA) at 2%O2 + 2% CO2 (CA1L – 'Ligol'), 1.2% O2 + 3.0% CO2 (CA1R – 'Red Jonaprince'), 0.8% O2 + 0.8% CO2 (CA2 – both cultivars), dynamically controlled atmosphere (DCA CF) and ILOS Plus (initial low oxygen stress). At harvest and after storage the background skin colour (BSC), fruit flesh firmness (FF), total soluble solids content (TSS) and titratable acidity (TA) were measured. Sensory analyses were performed after storage by expert panel.
Internal ethylene content (IEC), and the ethylene and carbon dioxide production rates were measured, to determine ripening stage of apples. ACC oxidase activity was measured and the incidence of diseases and disorders was determined after storage.
Analyses performed after storage confirmed the beneficial effects of low oxygen technology and post-harvest 1-MCP treatment on fruit firmness and acidity, for both cultivars.
Post-harvest treatment with 1-MCP and use of low oxygen technology reduced the rate of ethylene production, regardless of the season, harvest date and storage temperature. The impact of low oxygen storage and 1-MCP treatment on ethylene pathway was also expressed in the decrease of ACC oxidase activity.
In case of 'Red Jonaprince' apples, only fruits treated with 1-MCP and stored in CA conditions were characterized by satisfactory firmness after storage. For untreated fruits, even those stored in DCA, a very strong decline of firmness during shelf life was noticed. Such a feature of the fruit firmness could be related to a very hot summer in the year 2018.

This work was performed in the frame of multiannual programme 2015-2020 "Actions to improve the competitiveness and innovation in the horticultural sector with regard to quality and food safety and environmental protection" (Task 3.5), financed by the Polish Ministry of Agriculture and Rural Development

Key words: fruit quality, sensory analyse, fruit firmness, TSS, ACC,

DYNAMIC CONTROLLED ATMOSPHERE (DCA CF) IN VEGETABLE STORAGE

Maria Grzegorzewska, Ewa Badełek, Kalina Sikorska-Zimny, Anna Wrzodak, Stanisław Kaniszewski

Research Institute of Horticulture, Konstytucji 3 Maja 1/3, Skierniewice, Poland
e-mail: maria.grzegorzewska@inhort.pl

Three vegetable species were taken to the investigation: broccoli, crispy lettuce, white head cabbage.

Broccoli

The research was carried out for two storage seasons on the cv. Parthenon F1 and only for one season on the Monaco F1. In both seasons the broccoli heads were stored at 0-1°C for 100 days. There was used the dynamic controlled atmosphere (DCA) with three CO2 level: 0.5%, 1.0% and 2.0%.

During storage the chlorophyll fluorescence measurements detected low oxygen stress (Fα) for broccoli below 0.4 %O_2 in the season 2016/2017 and below 0.3 in the season 2018/2019. DCA with all CO_2 concentrations influenced on rooting development inhibition, what contributed largely to maintaining better quality of broccoli stored at DCA than at regular atmosphere (RA).

Crispy lettuce

Two cultivars Celist and Gustinas were tested in 2016 and two others Ikebanas and Federico in 2017. The storage temperature in both years was 0-1°C, but the length of storage was different; in first year 5 week and in the next 4 weeks.

Low oxygen stress appeared at the concentration of 0,3%, so the O_2 content was kept at the level 0,4%. The obtained results showed that DCA did not improve the storage ability of lettuce because the pinking of leaf nerves developed in the same rate as in RA.

White head cabbage

Two varieties Typhon F1 and Transam F1 were taken to the experiments. Cabbage was stored at 0°C for 8 months. The Fα in one year was 0.3% but in the next year 0.5%.

Although cabbage in DCA kept better exterior appearance than in RA, the leaves in the middle parts of the heads were dark and destroyed. This proved, that in the atmosphere with very low concentration of oxygen in the outside leaves the process of respiration was carried out during whole storage period, while inside the heads, the oxygen was exhausted and began the anaerobic respiration. It played a major role in destroying the middle part of the heads.

A part of this work was performed in the frame of multiannual programme 2015-2020 "Actions to improve the competitiveness and innovation in the horticultural sector with regard to quality and food safety and environmental protection" (Task 3.5), financed by the Polish Ministry of Agriculture and Rural Development

Key words: broccoli, lettuce, cabbage, dynamically control atmosphere

STORAGE AND FRUIT QUALITY OF SELECTED CULTIVARS OF ASIAN PEARS

Anna Skorupińska, Dorota E. Kruczyńska, Karolina Celejewska, Krzysztof P Rutkowski., Zbigniew B. Jóźwiak

Research Institute of Horticulture, Konstytucji 3 Maja 1/3 str., Skierniewice, Poland
e-mail: anna.skorupinska@inhort.pl

Asian pears are not well known in Poland and grown only on a small scale. They are considered as dietary and healthy fruit. Pears are juicy, sweet, firm and crisp in texture. For these reasons, can be an interesting product for Polish consumers as a dessert fruit.
In the present study some fruit quality parameters of three Asian pear cultivars were evaluated after storage in regular air (RA) and controlled atmosphere (CA) conditions during two successive seasons (2013/2014 and 2014/2015).
Tested cultivars were: 'Chojuro', 'Hosui', and 'Yuan-Huang'. Pears were obtained from the Experimental Orchard of the Research Institute of Horticulture in Dąbrowice (located near Skierniewice). Two harvests were done each season. The fruits were stored for 3 and 6 months at 0 °C in regular air and in controlled (2% O2, 1% CO2) atmosphere conditions. On removal from storage, the fruits were placed at 18 °C for 7 days to simulate shelf life. After storage and after shelf life the following parameters were determined: flesh firmness, total soluble solids, titratable acidity, ethylene production, and respiration rate. The sensory evaluation was also performed.
Flesh firmness was higher for the pears stored in CA than for pears stored in RA conditions. Significant differences were observed after 3 and 6 months of storage for 'Chojuro' cultivar and after 6 months for 'Hosui' and 'Yuan-Huang'. There were no or small differences in soluble solids content between fruits stored in RA and CA. Pears 'Chojuro' and 'Hosui' after 6 months of RA storage were characterized by higher content of soluble solids than after CA. No differences were observed in titratable acidity and in sensory evaluations for overall fruit quality. Fruits after storage in RA were characterized by higher respiration rate than those stored in CA, but the differences were not always significant. No significant influence (in most cases) of storage conditions on ethylene evolution was observed. Taking into account the consumer's assessments, the storage of 'Chojuro', 'Hosui', and 'Yuan-Huang' Asian pears in controlled atmosphere conditions is not an effective measure to maintain higher quality.

Key words: controlled atmosphere, ethylene, flesh firmness, regular atmosphere, respiration, sensory evaluation, soluble solids, titratable acidity

PREHARVEST CONDITIONS AFFECT THE FRUIT QUALITY OF LONG SHELF LIFE TOMATO VARIETIES

Clara Pons[1,2], Jose Luis Rambla[1], Joan Casals[3], Richard Finkers[4], Jose Blanca[2], Peio Ziarsolo[2], Jaime Prohens[2], Antonio Monforte[1], Antonio Granell[1]

[1] Plant Genomics and Biotechnology, IBMCP (CSIC-UPV), Valencia,Spain
[2] COMAV, Universitat Politècnica de València, Valencia, Spain
[3] Fundacio Miquel Agusti, Universitat Politecnica de Catalunya, Castelldefells, Spain
[4] Plant Breeding, WUR-PRI, Wageningen, The Netherlands
e-mail: cpons@upvnet.upv.es

In the Mediterranean area there is a special type of traditional long shelf life (LSL) tomatoes, known as *'de penjar' 'de ramellet', 'da serbo', 'piennolo', 'invernale, 'd'appendere'*, that have slow ripening and a very long postharvest (up to 6 months). They were selected over the years by local farmers to thrive in the summer season in Mediterranean dry climate and are cultivated in very restricted watering conditions. Farmers argue that under these conditions, fruits have a longer shelf life and better quality characteristics. In order to obtain scientific evidence to farmers' observations, the effect of water stress on ripening and postharvest was analyzed at phenotypic and molecular (GBS, RT-PCR Fuidigm and metabolomics) levels in a collection of LSL traditional varieties from Spain and Italy. Results were compared with a panel of modern cultivars and hybrids, reported by the breeding companies as LSL, some with rin or nor mutations.

Phenotypic analyses indicate that water stress improves fruit quality traits (SSC, color, texture) and postharvest behavior (shelf life, wrinkling incidence, weight loss) depending on varietal group and origin. Moreover, in general traditional LSL tomatoes have better postharvest performance than modern LSL varieties in any water regime.

Haplotypes associated to different ripening groups were identified. The expression levels of key genes involved in the different aspects of ripening and postharvest in response to water stress were analyzed to get some insights in the underlying molecular mechanisms. In addition, differences in metabolites related with flavor and aroma before and during and post-harvest indicate that water stress affects fruit quality depending on the genotype.

Key words: tomato, postharvest fruit quality, long shelf life, water stress

POSTHARVEST STRATEGIES TO PRESERVE THE QUALITY OF FRESH AND PROCESSED CALÇOT (*ALLIUM CEPA* L.)

Gemma Echeverria[1], Gloria Bobo[1], Jordi Gine[1], Tomás Lafarga[1], J. Simó[2], Maribel Abadias[1], Ingrid Aguiló-Aguayo[1*]

[1] Institute of Agrifood Research (IRTA), XaRTA-Postharvest, Parc Científic i Tecnològic Agroalimentari de Lleida, Parc de Gardeny, Edifici Fruitcentre, 25003, Lleida, Spain
[2] Fundació Miquel Agustí, Campus del Baix Llobregat, Esteve terrades 8, 08860, Castelldefels, Spain
e-mail: Ingrid.Aguilo@irta.cat

Calçots are the floral stems of the second-year onion (*Allium cepa* L.) resprouts with economic importance in Spain, where they are usually consumed roasted. Postharvest strategies including controlled atmospheres (CA) and passive modified atmosphere packaging (MAP) were evaluated to extend the shelf-life of fresh calçots. The effect of two CA of 1% O_2 + 2% CO_2 (CA1) and 1% O_2 + 10% CO_2 (CA2) using micro-chambers were compared with air conditions at 0.5°C and 90% RH for 60 days. On the other hand, MAP conditions using Xtend® 815-ON557b and Xtend® 815-SF 30/R bags were also evaluated as a postharvest packaging calçot strategy at 4°C and 90% RH for 40 days. Ethylene production and respiration rates were evaluated throughtout the conservation period. Physicochemical, nutritional and sensory quality of fresh and roasted calçots were studied. CA2 conditions could extend shelf-life of fresh calçots up to 60 d of storage without causing physiological disorders and showing the highest liking degree after roasting. In addition, samples showed higher total phenolic and flavonoid content under this storage conditions compared to CA1 and air. Regarding the MAP strategy, Xtend® 815-ON557b bags represented a good alternative to extend the shelf life of fresh calçots up to 40 days at 4°C related to a good equilibrium levels reached favorable to preserve the product. This MAP conditions also resulted in a final fresh product with better texture attributes as well as higher consumer acceptance compared to those samples stored with Xtend® 815-SF 30/R bags. Both CA and MAP strategies showed potential commercial uses for a longer period of calçot storage.

Key words: calçot, postharvest, packaging, atmoshphere

ACTIVE GLUCOMANNAN COATING TO PROLONG THE QUALITY OF BANANA

Rungsinee Sothornvit

Department of Food Engineering, Faculty of Engineering at Kamphaengsaen, Kasetsart University, Kamphaengsaen Campus, Nakhonpathom, 73140 Thailand
e-mail: fengrns@ku.ac.th

Edible films and coatings have been applied in various food products and agricultural produces. Ripe ivory gourd (IG) is agricultural waste and can act as antioxidant to prolong the quality of banana. Activated carbon (AC) has a capacity to absorb ethylene which is a catalyst for fruit ripening. Therefore, the objective of this study was to determine the effectiveness of active glucomannan (G) edible coating incorporated with IG and AC on the quality of banana. It was found that IG juice showed antioxidant activity with inhibitory concentration at 50% DPPH (IC50 = 0.27 mg/L). Glucomannan was formed with AC and IG as active edible coatings and applied on banana to prolong the banana's qualities during storage at ambient temperature. As shown, the G edible coating maintained quality of banana in terms of firmness and delay the disease severity than other coatings. Incorporation of AC and IG did not enhance quality of banana from G coating. Thus, the study on edible coatings to maintain food products and agricultural produce is still necessary and important to reduce the loss of commodity.

Key words: glucomannan, ivory gourd, activated carbon, edible coating, banana, fruit quality

HYDROXYPROPYL METHYLCELLULOSE–BASED EDIBLE COATINGS FORMULATED WITH ANTIFUNGAL FOOD ADDITIVES TO REDUCE ALTERNARIA BLACK SPOT AND MAINTAIN POSTHARVEST QUALITY OF COLD-STORED 'ROJO BRILLANTE' PERSIMMONS

D. Villamón, L. Palou, M.B. Pérez-Gago

Postharvest Technology Center (CTP), Valencian Institute of Agrarian Research (IVIA), Ctra, CV-315, km 10.7, 46113 Moncada, Valencia, Spain
e-mail: perez_mbe@gva.es

Main challenges for the fresh persimmon industry are to extend the fruit storage life and hence prolong the commercialization period, which requires effective methods to control postharvest black spot caused by the pathogenic fungus *Alternaria alternata* and reduce fruit softening caused by chilling injury. Edible composite coatings based on hydroxypropyl methylcellulose (HPMC)-beeswax (BW) were prepared with 2% (w/w) potassium bicarbonate (PBC) or 0.1% (w/w) sodium ethylparaben (SEP) as antifungal ingredients and applied to 'Rojo Brillante' persimmons artificially inoculated with *A. alternata*. Coated fruit were incubated at 20°C for up to 12 days. Fruit weight loss, firmness, and respiration were also evaluated on coated intact 'Rojo Brillante' persimmons stored at 1°C for up to 30 days followed by a shelf-life period of 7 days at 20°C. The coating containing 0.1% SEP was the most effective to reduce persimmon black spot, with a reduction of disease incidence (percentage of infected fruit) and severity (lesion diameter) of around 50% and 65%, respectively, after 12 days at 20°C. These coatings significantly reduced weight loss and maintained the firmness of coated persimmons, while significantly reduced the CO_2 production during cold storage plus 7 days at 20°C, indicating the creation of a modified atmosphere in the fruit that could explain their effect reducing chilling injury. In conclusion, HPMC-BW coatings containing the food additive SEP at 0.1% could be a promising treatment to extend the postharvest life of 'Rojo Brillante' persimmon by reducing Alternaria back spot and chilling injury.

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Key words: hydroxypropyl methylcellulose (HPMC) edible coating, *Alternaria alternata*, postharvest disease management, weight loss, firmness, chilling injury

AIRFLOW DISTRIBUTION AND MANAGEMENT IN AN APPLE STORAGE ROOM

Martin Geyer[1], Daniel A. Neuwald[2], Reiner Jedermann[3], Ulrike Praeger[1]

[1] Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB), Department Horticultural Engineering Max-Eyth-Allee 100, 14469 Potsdam, Germany
[2] Competence Centre for Fruit Growing—Lake Constance, (KOB), Schuhmacherhof 6, 88213 Ravensburg, Germany
[3] Institute for Microsensors, -actuators and –systems (IMSAS), University Bremen, Otto-Hahn-Allee NW1, 28359 Bremen, Germany
e-mail: mgeyer@atb-potsdam.de

In cold stores of fruit and vegetables air circulation is necessary in order to remove field and respiration heat of the produces and to minimize temperature gradients in the rooms. Maintenance of homogenous temperature and humidity adapted to the requirements of the produces prevents quality loss due to respiration, water loss, or infestation with pathogens. Therefore uniform airflow distribution in the product stack is important in cold stores. However, the air speed inside the bins nearby the produce is unknown. The aim of this study was to determine the airflow distribution in an industrial apple storage room in the gaps between the bins and inside the bins during common fan operation and reduced fan power.
In the presented study air speed distribution was measured inside big bins and in vertical gaps between the bins in a 70 ton apple storage room at different fan power with common stacking layout. Newly developed wireless anemometers were used for two-dimensional air velocity measurement between the gaps and new omnidirectional air speed sensors for flow determination between fruit.
In the vertical gaps of the bin stack in discharge direction of the fans, the flow direction measured showed that at 100% fan power an air roll has formed over the entire stack height and width with relatively uniform air velocity at every position. On the other hand the air speed between the fruit was low with values ≤ 0.3 m/s compared to the average air speed in the neighboring gap of 1.15 m/s at 100% fan power. It was not related to the airflow distribution in the vertical gaps. In the bins in the upper stack area, the air speed was about 7 times as high as in the bins in the bottom layer. Standard large plastic bins cause high air resistance mainly due to the small opening area of about 10% of the walls and bottom. Thus, wall porosity is considerably lower than porosity of the apple bulk with a hollow space content of 41.
Reducing the fan revolution immediately resulted in reduced air speed in the gaps and between the fruit. However, air flow was detected at all measuring positions, even when the fan power was reduced to 44%.

Key words: cold store, fruit bin, air speed, airflow sensor

AN ATTEMPT TO MEASURE TEMPERATURE DISTRIBUTION ACROSS A GLYCOL TYPE, FIN COIL AIR COOLING UNIT – A PRACTICAL APPROACH

Zbigniew B. Jóźwiak

Department of Fruit Storage and Processing, Research Institute of Horticulture (InHort),
Konstytucji 3 Maja 1/3 Str., 96-100 Skierniewice, Poland
e-mail: zbigniew.jozwiak@inhort.pl

For the past several decades, the refrigeration industry is faced with problems associated with removal from the market effective refrigerants (freons) due to either Ozone Depletion Potential (ODP - CFCs, HCFCs) or Global Warming Potential (GWP - HFCs). Starting January 1-st 2020 only refrigerants with GWP lower than 2500 will be allowed on the market, for the newly erected medium and large scale installations. Available refrigerants will be either natural hydrocarbons (propane R290, isobutane R600a) or fluorinated olefins (HFOs), eventually ammonia (NH_3 – R717) or carbon dioxide (CO_2 – R744). Most of them are flammable or even explosive, some are toxic (NH_3) or exhibit very high pressure in the system in overcritical conditions, otherwise require two-stage cooling units (CO_2). Because of those restrictions, there is a growing interest in indirect (glycol based) cooling systems, with the machinery room moved outdoor from the cold storage facility to a separate building, just for the safety purposes. Another restriction is related to, so called, Green Energy Systems, or carbon footprint, which requires from the cold storage installations a limitation exhibited on the electrical power consumption level. A typical glycol based cold storage room arrangement consists of a fin coil block air cooler, equipped with air mixing fans, glycol recirculation pump and 3-way proportional mixing valve. RPM of fans and pump might be regulated and the positioning of the mixing valve can be optimized to obtain working conditions allowing for the maintenance of the technologically proper low and constant temperature and high relative humidity conditions, with equilibrated air distribution through the cold storage room.

In the present study, to gather more information pertaining to the working conditions of the cooling system, an attempt was made to measure the temperature distribution across the fin coil block of the glycol based room air cooler, type BMG-38-300E (PPUCH Tarczyn, Poland), using 16 Programmable Resolution 1-Wire Digital Thermometers, type DS18B20 (Maxim Integrated, USA), linked to a PLC regulator, type MSR2W (PCTherm, Poland), connected via the RS485/USB converter to a laptop PC equipped with 'Rejestrator 9.2' type software for the measurements, visualization and storage of the temperature data, in the time domain. Temperature distribution was measured within 1 of the 6 'pipe and elbow' sections of the fin coil, along with the temperatures of air entering and leaving the fin coil block, and blown out by the circulation fan. In the second stage, temperature measurements between the 6 sections were made, pairwise on the inlet and outlet manifolds, as well as on the inlet and outlet of the circulation pump, and supply and return pipes to the cold glycol tank. Preliminary results of the temperature measurements have shown the system has a good potential as a base for modeling and the optimization process of the cooling units, but requires additional refinements and further study.

Key words: refrigeration, fin coil, indirect cooling, temperature distribution, modelling, optimization

4th International Conference

"Effects of Pre- and Post-harvest Factors on Health Promoting Components and Quality of Horticultural Commodities"

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ABSTRACTS OF POSTERS

EFFECT OF CA AND MAP CONDITIONS ON HONEYSUCKLE FRUIT QUALITY AFTER SHORT-TERM STORAGE

Jan Błaszczyk, Ewa Dziedzic, Monika Bieniasz

University of Agriculture in Krakow, Poland
e-mail: j.blaszczyk@urk.edu.pl

Berry fruits of four honeysuckles cultivars − 'Aurora', 'Vostorg', 'Indigo Gem' and 'Honeybee' were collected from a commodity plantation. The plantation has been founded in year 2015, from plant material propagated by *in vitro* method.
The harvest date was determined on the basis of visual assessment of fruit and soluble solids content in fruit (minimum 12.5%).
The collected fruits were stored in the three storage conditions: normal atmosphere (NA), controlled atmosphere (CA), containing 20% CO_2 and 5% O_2 and modified atmosphere using Xtend® bags (MAP).
Immediately after harvest weight of 50 fruits of each cultivar was determined. After 7 and 14 days of storage period the following fruit parameters were evaluated: fruit firmness [N], soluble solids content [%], titratable acidity [% citric acid], respiration rate [mg CO_2 x kg^{-1} x h^1] and natural weight losses of fruits [%].
'Vostorg' was characterized by the largest average weight of fruits (67.7 g), 'Aurora' (56.9 g) and 'Honeybee' (49.0 g) had smaller fruits, and 'Indigo Gem' (39.1 g) had the smallest mass of fruit.
The results showed that both the conditions and length of storage period had a significant impact on the quality of honeysuckle fruits. Longer storage period (14 days) most often negatively affected the quality of tested fruit. Fruit stored in CA conditions and Xtend® bags, were usually characterized by a higher firmness and acid content, lower respiration rate and smaller weight losses compared with berries from NA. Fruits stored in a controlled atmosphere and Xtend® bags exhibited the similar quality parameters. The usefulness of Xtend® bags for short-term storage of honeysuckle fruits has been demonstrated.

Key words: 'Aurora', 'Vostorg', 'Indigo Gem', 'Honeybee', fruit firmness, soluble solids content, titratable acidity, respiration rate, Xtend bags

PRELIMINARY STUDIES ON THE STORAGE OF BLUE HONEYSUCKLE (*LONICERA CAERULEA*) BERRIES

Justyna E. Bojarska[1], Bogumił Markuszewski[2], Katarzyna M. Majewska[1], Wioletta Józefowicz[1], Anna Bieniek[2]

University of Warmia and Mazury in Olsztyn, [1]Faculty of Food Science, Department of Food Plant Chemistry and Processing, [2]Faculty of Environmental Management and Agriculture, Department of Horticulture
e-mail: justyna.bojarska@uwm.edu.pl

The berries of Blue Honeysuckle containing a significant amount of biologically active substances can be included in the group of so-called 'superfruits'. Due to their growing popularity and low durability, the aim of the work was to determine the most favourable conditions for their storage.
The fruits of the studied cultivars, 'Wojtek' and 'Zojka', came from a commodity plantation. The berries were kept for six weeks in the following conditions: normal atmosphere (NA – standard cold storage, 0-1°C, 85-95% relative humidity); controlled atmosphere (CA – 5% O_2 : 15% CO_2, 85-95% relative humidity) and Xtend® MA/MH Packaging (Modified Atmosphere Packaging bags). In the stored samples, the texture, weight of 100 fruits, total extract, total acidity, content of vitamin C, total polyphenol, anthocyanins, as well as the degree of infection with fungal and physiological diseases, were determined.
Fruit of Blue Honeysuckle berries stored in CA conditions showed the lowest mass loss and the lowest degree of infection with fungal and physiological diseases throughout the storage period. There was a significant decrease in the anthocyanin content in the samples stored in Xtend® bags. The 'Zojka' cultivar was characterized by a higher fruit storage capacity than the 'Wojtek' cultivar.

Key words: Blue Honeysuckle berries, storage, fruit quality

STORAGE OF PLUMS UNDER DYNAMIC CONTROLLED ATMOSPHERE

Auri Brackmann, V. Both, S.F.P Schmidt, F.R. Thewes, V. Ludwig, L.M. Wendt

Department of Plant Science, Postharvest Research Center, Federal University of Santa Maria, Roraima Avenue 1000, Camobi, Santa Maria 97105-900, RS, Brazil
e-mail: auribrackmann@gmail.com

In Brazil, most companies store the 'Laetitia' plums until two months at 1.5°C, in CA with 1 to 2 kPa O_2 and 1 to 2 kPa CO_2, even then, quality losses are present. Thus, the aim of our study was to evaluate the possibility to store 'Laetitia' plums under dynamic controlled atmosphere (DCA) and determine the lower oxygen limit (LOL) over the storage period with three different DCA methods. 'Laetitia' plums, harvested at the 2018/2019 season were stored at two temperatures and submitted to LOL monitoring based on three DCA methods. Every treatment was composed by 4 replicates of 40 fruit. The plums were stored in CA (1 kPa O_2 + 1.5 kPa CO_2) and in three distinct DCA conditions (both with 1.5 kPa CO_2), monitored by Respiratory Quotient (DCA-RQ 1.5) and two innovative DCA methodologies (method 1 and method 2) to monitor the plums LOL over the storage. Fruit of each CA and DCA condition were stored at two different temperatures (0.5 and 2.0°C). Distinct oxygen behaviour was observed between the three DCA methods at 0.5°C, where DCA-RQ1.5 had mean oxygen setpoint (1.26 kPa O_2), followed by method 1 (0.62 kPa O_2) and method 2 (0.32 kPa O_2). DCA-RQ 1.5 at 0.5°C maintained a higher setpoint then at temperature of 2.0°C (0.53 kPa O_2). Method 1 reached a similar setpoint for both temperatures. The lowest O_2 setpoints were reached by the new method 2 (0.32 kPa O_2 at both temperatures. There is a notable interaction between DCA-RQ 1.5 and storage temperature. At 2.0°C DCA-RQ 1.5 stored plums tend to tolerate lower O_2 concentration, when compared to 0.5°C. However, for both new methods the O_2 setpoint did not significantly differ between temperatures, showing that the LOL estimation is different according to the DCA method employed. The distinct setpoint behavior were not efficient to prevent internal browning after three months storage, although DCA-RQ, method 1 and 2 at 0.5°C had lower decay incidence, when compared to conventional CA.

Key words: 'Laetitia' plums, respiratory quotient, DCA, DCA-RQ, LOL,

BIOCHEMICAL COMPOSITION AND ANTIMICROBIAL PROPERTIES OF EUROPEAN CRANBERRY BUSH (*VIBURNUM OPULUS*) FRUITS

Laima Česonienė[1], Remigijus Daubaras[1], Antanas Šarkinas[2]

[1] Vytautas Magnus University, Botanical Garden, Ž.E. Žilibero 6, Kaunas, Lithuania
[2] Kaunas University of Technology, Food Institute, Radvilėnų pl. 19, Kaunas, Lithuania
e-mail: laima.cesoniene@vdu.lt

European cranberry bush *Viburnum opulus* L. has a long history of use in food and folk medicine. Fruits help to overcome nervous disorders, they have been used to treat different maladies including heart diseases, digestive troubles, cough and cold. Fruits of this plant tend to be bitter. However, prolonged selective pressure on *V. opulus* has resulted in breeding new cultivars in Russia and Ukraine. These cultivars are distinguish by large fruit with better gustatory properties and high amounts of biologically active substances. One of the most important aspects of conservation and preservation of *V. opulus* genetic resources is the biochemical composition of fruit.

Different cultivars and clones of *V. opulus* were compared according to the amounts of ascorbic acid, total phenolics, anthocyanins, flavonols and benzoic acid. The average amount of ascorbic acid in the fruit of *V. opulus* was 27 mg/100g. The Lithuanian clone P1 and the cultivar 'Leningradskaja Otbornaja' accumulated the largest amount of ascorbic acid. Statistically reliable differences were ascertained in the amounts of anthocyanins and flavonols. The accessions accumulated from 21.0 mg/100g ('Souzga') to 40.0 mg/100g ('Leningradskaja Otbornaja') of anthocyanins and from 14.5 mg/100g (the clone P2) to 19.1 mg/100g ('Krasnaja Grozd') of flavonols. The amount of benzoic acid of *V. opulus* accessions ranged from 8.2 mg/100g to 16.0 mg/100g. The results of biochemical investigations corroborated that selection of *V. opulus* accessions in respect of benzoic acid, anthocyanins, and ascorbic acid amounts could be advisable. Antibacterial effect of methanol extracts of *V. opulus* fruits by using the agar diffusion method was tested against ten bacterial cultures, some of them pathogenic and some of them spoilage microorganisms. In our study juice of *V. opulus* fruits inhibited the growth of Gram-positive and Gram-negative bacteria. All cultures tested were sensitive, however effect of inhibition was different. The most resistant bacterial cultures were *Micrococcus luteus* and *Staphylococcus epidermidis*. Results of our investigations corroborated high antibacterial activity of *V. opulus* juice against harmful *Salmonella typhimurium, Lysteria monocytogenes, Salmonella agona, Enterococcus faecalis,* and *Staphylococcus aureus cultures*.

Key words: ascorbic acid, total phenolics, anthocyanins, flavonols and benzoic acid

THE EFFECT OF 1-MCP TREATMENT ON STORAGE ABILITY OF BROCCOLI AND CHINESE CABBAGE

Maria Grzegorzewska, Ewa Badełek, Kalina Sikorska-Zimny, Krzysztof P. Rutkowski, Karol Fabiszewski, Anna Ciecierska

Department of Fruit and Vegetable Storage and Processing, Research Institute of Horticulture, Konstytucji 3 Maja 1/3, Skierniewice, Poland
e-mail: maria.grzegorzewska@inhort.pl

The very compact heads of broccoli cv. Parthenon F1 were taken to the experiment. Right after harvest the stems and leaves were trimmed. Next the heads were treated with 1-MCP for 20 hours in gas-tight containers at 5°C. The concentrations of 1-MCP were as follows: 1.0 $\mu L \cdot L^{-1}$ and 3.0 $\mu L \cdot L^{-1}$. Not treated heads consisted as control object. Then the heads were stored at 0°C, one part for 30 days and another part for 60 days. After the cold storage, broccoli were kept for some days at shelf life conditions (temperature 16°C).
After 30 days of cold storage there were no signs of rot and the heads had very good color and firmness. The overall quality was rated as good in all experimental objects. After transferring the broccoli to the shelf life conditions, the heads maintained the good and fairly good quality for 4 days. In the next days the yellowing and decreasing quality were observed, especially in the control object.
While broccoli were stored for 60 days, a slight decreasing in quality was found for heads not treated with 1-MCP, mainly due to signs of senescence on the stalks at the points of the leaf cut off. After transferring to the shelf life, the treated broccoli (both concentrations of 1-MCP) remained usable for market for 4 days while not treated only for 2 days.
Chinese cabbage cv. Bilko F1 was treated by 1-MCP according to the same protocol as broccoli. After treatment cabbage were stored at 1-2°C for two storage time: one part – 2.5 months and second part – 4.0 months. Following cold storage, cabbage was kept at shelf life conditions (temperature 16°C).
The obtained results showed that 1-MCP treatment (concentration 1.0 $\mu L \cdot L^{-1}$ and 3.0 $\mu L \cdot L^{-1}$) did not improve the storage ability of Chinese cabbage. During cold storage for 2.5 months as well as 4,0 months the senescence process and rotting of leaves occurred at a similar rate in all experimental objects. During the shelf life, the main reason of quality decreasing was the disease affecting, caused by *Xanthomonas campestr*is, which developed similarly in all combinations (treated and not treated).

Key words: broccoli, Chinese cabbage, 1-MCP treatment, storage

DISTRIBUTION OF QUERCETIN GLYCOSIDES IN ONION DEPENDING ON THE CULTIVAR, SIZE AND PEELING METHOD

Katarzyna Grzelak-Błaszczyk[1], Robert Klewicki[1], Agata Swaczyna[1], Maria Grzegorzewska[2]

[1] Faculty of Biotechnology and Food Sciences, Institute of Food Technology and Analysis, Łodz University of Technology, Stefanowskiego 4/10, Łodz, Poland
[2] Research Institute of Horticulture, Konstytucji 3 Maja 1/3, 96-100 Skierniewice, Poland
e-mail: katarzyna.grzelak-blaszczyk@p.lodz.pl

Health-beneficial effects of onion are attributed most of all to prebiotic compound contents (quercetin glycosides). The aim of the study was to determine the content of quercetin glycosides in onions, depending on cultivar, size and distribution of quercetin glycosides in the scales of onions. The presented research characterizes the quercetin glycosides composition of commercially important onion cultivars grown in Poland ('Alonso F1', 'Hysky F1', 'Hystore F1' and 'Robusta'). 'Alonso F1' is an early cultivar, recommended for long-term storage. 'Hysky F1' is a relatively new cultivar, with high tolerance towards fungi of the Fusarium genus. 'Hystore F1' is a late cultivar intended for very long storage. 'Robusta' is known as late cultivar, cultivated in Poland for over 30 years. The method of onion peeling has the impact on the quantity and quality of the waste. As a result of manual peeling, the outer dry scales are mainly removed, while during the machine peeling one or two fleshy scales are also removed. The quercetin glycosides were measured in the outer dry scales and flesh scales of four onion varieties. Samples were crashed in liquid nitrogen and the dry matter content were determined by AOAC method. Content of quercetin glycosides and quercetin were determined by HPLC method with DAD detection. The outer dry scales contains more quercetin aglycone, while the two flesh scales contain the majority of quercetin 4'-O-glucoside and quercetin 3,4'-O-glucoside. Among the analyzed cultivars, 'Robusta' cultivar was the richest in quercetin glycosides, while 'Alonso' cultivar was the poorest, 947 and 440 mg/100g d.m., respectively. The size of onions does not affect the content of quercetin glycosides. The method of peeling onions has a significant impact on the content of glycosides in the peeled vegetable. Depending on the method of onion peeling, up to 50% of glycosides can be lost.

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Key words: onion, cultivar, quercetin glycosides

MODULAR SENSOR-BASED RESPIROMETER FOR IN-SITU REAL-TIME MONITORING OF RESPIRATION RATE

Nandita Keshri, Ingo Truppel, Werner Herppich, Martin Geyer, Pramod Mahajan

Department of Horticulture Engineering, Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB), D-14469 Potsdam, Max-Eyth-Allee 100
e-mails: NKeshri@atb-potsdam.de; PMahajan@atb-potsdam.de

Respiration rate of fruit and vegetables is an important physiological parameter to measure for designing MA-packaging or CA-storage systems. Conventional systems of measurement rely on GC or gas analyzers which needs manual sample handling and draws a considerable amount of gas from the system. A new Respiration Measuring Sphere of 88 mm diameter (RMS88) was developed in ATB that measures O_2, CO_2, temperature and humidity. Based on RMS88, a compact (free volume of 3.3 L) and modular respirometer was developed. With the help of a software, real-time and in-situ respiration rate (O_2 consumption and CO_2 consumption) as well as respiratory quotient (RQ) was obtained. Such a compact system can be used in DCA storage systems for remote and in-situ measurement of respiration rate and RQ and will be helpful for continuous and non-invasive monitoring of the physiological conditions of stored fruits.

Key words: CA-storage, measuring sphere, CO_2, O_2

THE EFFECT OF DIFFERENT CALCIUM APPLICATIONS TO OCCURRENCE OF BITTER PIT AND SUSCEPTIBILITY TO BRUISING AFTER STORAGE OF 'SWEETANGO' APPLES

Nadine Klein, Daniel Neuwald

Competence Centre for Fruit Growing at Lake Constance (KOB), Schuhmacherhof 6, Ravensburg, Germany
e-mail: nadine.klein@kob-bavendorf.de

'SweeTango' as early ripe apple cultivar is highly susceptible to bruising. The supply of calcium and its deficit is an important topic due to the warm weather conditions which affects the transpiration and so the transport of nutrients in the xylem. Both, bruising and bitter pit as a symptom of a deficiency of calcium might get reduced by spraying calcium pre-harvest. This was topic of a trial, conducted at KOB in South Germany in 2018. There was an untreated control (UTC), application of 5 kg calcium chloride and of 5 kg Folanx-Ca29 every 7 days and Folanx-Ca29 every 14 days, starting 7 weeks pre-harvest. Folanx-Ca29 is a Calcium formulated product with 29% calcium content. Additionally, fruit of the untreated control were dipped into distillated water and into a 1% Düngal-solution for 2 minutes. Düngal is a fertilizer with 17,5% water-soluble oxide of calcium. Fruit were stored in cool-storage and in controlled atmosphere (1.0 kPa O_2, 2.5 kPa CO_2) at 1°C for 6 months. Fruit quality was analyzed at start of storage, after removal of storage and after 7 days shelf life at 20°C. Additionally to firmness, total soluble solids, titratable acidity and ground colour, mineral content, bitter pit and susceptibility to bruising was analyzed. Bruises were provoked intentionally and calculated as an index by letting a 7 g lead ball drop through an acrylic glass tube in height 5, 10, 15, 20, 25 and 30 cm respectively on the shaded side of the fruit. Even though there is no obvious difference in relation of K to Ca between variants, the susceptibility to bruising was decreased when fruit were treated with calcium chloride. Anyway, the differences between storage conditions were more obvious. When stored in RA the fruit were less susceptible to bruising, probably because of the higher loss of water and the resulting less tense skin of the fruit. No differences between calcium variants regarding firmness, TA, TSS, ground colour or bitter pit were observed.

Key words: mineral content, calcium deficiency, dipping, fruit quality

POSSIBILITIES FOR THE EXTENSION OF SHELF LIFE OF JAPANESE QUINCE FRUIT

Inta Krasnova, Karina Juhņeviča-Radenkova, Dalija Segliņa

Institute of Horticulture, Graudu Street 1, Cerini, Krimunu distr., Dobele, LV 3701, Latvia
e-mail: inta.krasnova@llu.lv

To evaluate the influence of 1-methylcyclopropene (1-MCP) treatment and ultra-low oxygen storage system (2.5% CO_2 and 1.5% O_2) on the physical and chemical attributes during long-term storage of Japanese quince (*Chaenomeles japonica*) fruit, a two-year study was conducted, using the following cultivars: 'Darius', 'Rasa', 'Rondo', 'Ada'. Fruits were harvested twice in 2017 and 2018 year with the following 6-months storage. The degree of maturity was determined based on the ethylene content as well as evaluating the degree of fruit yellowness and seed color. The alterations in physical and chemical attributes (yellowness, weight loss, firmness, soluble solids content, titratable acidity, vitamin C and total phenols content) were examined. Within the research, it revealed that ethylene concentration at fruit harvest is a good indicative parameter that to be taken into consideration for proper selection of Japanese quince. To a greater extent harvest time and thickness of the fruit skin have resulted in decline of fresh weight and firmness. The most substantial positive effect on physical parameters has been achieved when ultra-low oxygen storage was applied. In general, all cultivars had retained better quality with regards to firmness and fresh weight loss.
Assessing the changes in chemical attributes of Japanese quince during the storage, it was noted that the quality is closely related to moisture content. Storage of Japanese quince fruit under ultra-low oxygen conditions, as well as treatment with 1-MCP had ensured superior preservation of total phenols and higher antioxidant activity compared to control samples. Better results remained for cultivar 'Rasa' fruits.

Key words: *Chaenomeles japonica*, ethylene, physical and chemical attributes

PRESERVATION OF PEARS, DEPENDING ON THE DOSE OF POSTHARVEST TREATMENT INHIBITOR ETHYLENE 1-MCP

Oleksandr Melnyk, Olga Drozd

National University of Horticulture, Uman, 20305 Ukraine
e-mail: ovm.novsad@gmail.com

The aim of the research was to determine the effect of postharvest SmartFresh treatment of pears (various 1-MCP doses) on the natural weight losses, skin browning, senescent breakdown and ethylene-production, firmness, soluble solids content, titratable acidity and taste during fruit refrigeration storage. Autumn pears of local variety were picked at a commercial harvest time. Fruits were cooled to 5°C and treated with doses of 500, 750 and 1000 ppb 1-MCP for 24 hours, then pears were stored at 2 ± 1°C and humidity 90-95% (non-treated fruits – control). The intensity of ethylene production was measured with gas analyser ICA-56, the flesh firmness was determined with penetrometer FT-327 with an 8-mm plunger, the content of soluble solids was estimated with a refractometer and titratable acidity was determined. After a week shelf-life, aroma, hardness, crispiness, juicy, oiliness, sweet taste, sour taste and overall assessment were assessed.

Without treatment with an ethylene inhibitor, the post-harvest ethylene activity of freshly collected pears at 20°C for 20 days increased steadily, while in 1-MCP treated ones it was 18.3-20.6 times less than the untreated fruit value, regardless of the dose. After five months of storage, untreated fruits emitted 3.4-29.4 times more ethylene than those treated with 1-MCP. After six months of storage, the highest level was observed in fruits treated with a dose of 500 ppb and the parameter of the fruits treated with doses of 750 and 1000 ppb was lower by 5.6-5.5 times.

The flesh firmness of the untreated fruits at a level of 4.0 kG (tolerable for trade) is provided with a three-month maximum of pear storage at 2 ± 1°C. At the end of the four-month storage of fruits with 1-MCP treatment, the rate was 1.9-2.2 times higher, in addition, the firmness of fruits treated with a dose of 500 ppb decreased faster and it reached a lower level by 10% in comparison with the results of treatment with doses of 720 and 1000 ppb.

After four months of storage, a higher content of dry soluble substances was found in untreated fruits as well as in fruits with a treatment dose of 750 ppb. The index was 0.4% lower in the option with 500 ppb treatment and 0.7% lower - after treatment with a dose of 1000 ppb. The treatment with a dose of 500 ppb provided a 2.1-2.2 times higher flavor estimate, 1.5-1.8 higher juiciness, 2.5-3.2 higher oiliness and 1.5 times higher sweetness as compared with doses of 750 and 1000 ppb. All this provided the highest overall assessment of the fruits – 1.4-1.6 times.

After four months of storage, the natural losses of untreated fruit were 1.6-1.8 times higher than those of the treated ones, whereas natural losses of 500 ppb treated fruit were 1.1-1.2 times lower than those treated with doses of 750 and 1000 ppb. With the losses lower than 10%, pears without treatment of 1-MCP can be stored at 2°C for no more than three months and those treated with an ethylene inhibitor – for no more than four months. As the storage duration of 1-MCP treated products increases, damage to the skin browning slightly increases without a significant difference between the doses studied.

Therefore, a high efficiency of post-harvest treatment of autumn pears with an ethylene inhibitor is achieved at doses of 500, 750 and 1000 ppb 1-MCP. A more harmonious taste of fruits is achieved after the use of smaller doses of 1-MCP.

Key words: skin browning, senescent breakdown, ethylene-production, firmness, soluble solids content, titratable acidity, sensory evaluation

BIOCHEMICAL CONTENT AND YIELD OF SOME CULTIVARS OF GREEN BEAN (*PHASEOLUS VULGARES* L.) UNDER MOSCOW REGION CONDITIONS (NONCHERNOZEM BELT OF THE RUSSIAN FEDERATION)

Anna V. Molchanova, A.A. Antoshkin, A.M. Smirnova

Federal State Budgetary Scientific Institution "Federal Scientific Vegetable Center" (former All-Russian Research Institute of Vegetable Breeding and Seed Production)
Selectionnaya street, 14, VNIISSOK, Odintsovo district, Moscow region, Russia, 143072
e-mail: vovka_ks@rambler.ru; aa_antoshkin@mail.ru

Green bean (*Phaseolus vulgaris* L.) is widely known and popular on all continents of the globe. This crop plays an important role in reducing the deficit of wholesome proteins in human nutrition. Federal Scientific Vegetable Center is working on the most important economically valuable traits due to the increased demand for domestic vegetable beans for freezing, canning and cooking in the Russian Federation.
Evaluating and taking into account the main biochemical parameters such as high content of dry matter, carbohydrates, starch, ascorbic acid, total content of antioxidants are crucial for quality breeding.
Four cultivars of Lika, Ulyash, Si Bimol', Sekunda (standard) were used. The results of the biochemical analysis of vegetable bean varieties at the fully grown stage showed that the dry matter content of Lika (8.77%) significantly exceeded the standard sample cv. Sekunda. The cv. Si Bimol' variety also demonstrated a tendency (8.14%) to exceed the standard
Cv. Ulyash (2.6%) and cv. Si Bimol' (2.65%) had a tendency to exceed the standard in the content of monosaccharides; in terms of the total amount of sugar cv. Ulyash and cv. Si Bimol' significantly exceeded the standard (2.82% and 2.83%, respectively). Cv. Lika significantly and considerably exceeded the standard in the amount of sugars (3.12%). In terms of starch content, all the studied varieties were comparable to the standard sample. The highest content of ascorbic acid and the largest amount of water-soluble antioxidants among the studied vegetable bean varieties was demonstrated by cv. Lika (13.2 mg% and 6.37 mg/g EAK, respectively). According to the obtained results, the cultivars of green beans are a valuable dietary product.

Key words: dry matter, carbohydrates, starch, ascorbic acid, antioxidants

THE CHANGES IN QUALITY OF SOILLESS CULTIVATED CHERRY TOMATOES AFTER BIOCHAR APPLICATION AND SHIFT OF MICROBIAL COMMUNITIES OF THE RHIZOSPHERE

Federica Piergiacomo[1], Kalina Sikorska-Zimny[2], Luciano Beneduce[1]

[1] Department of the Sciences of Agriculture, Food and Environment, University of Foggia, Via Napoli, 25 - 71122, Foggia, Italy
[2] Fruit and Vegetables Storage and Processing Department, Research Institute of Horticulture, Konstytucji 3 Maja 1/3, 96-100 Skierniewice, Poland
e-mail: federica_piergiacomo.551995@unifg.it

According to International Biochar Initiative Scientific Advisory Committee (Hunt et al. 2010) "Biochar is a fine-grained charcoal high in organic carbon and largely resistant to decomposition. It is produced from pyrolysis of plant and waste feedstocks. The enhanced nutrient and moisture retention capacity of biochar-amended soil not only reduces the total fertilizer requirements, but also may reduce the climate and environmental impact of croplands". It is worthy of investigation whether biochar may have beneficial effects also hen not used as soil amending agent but directly applied in contact with plant root in soilless culture systems. Therefore, authors decided to conduct an experiment in which cherry tomatoes cultivated in rockwool (in greenhouse) were added with biochar (liquid and solid). After harvest chemical and microbial analysis were conducted.
Results obtained confirmed that a significant increase of lycopene and vitamin C content of tomatoes was reached when biochar was added to the roots, particularly solid biochar. The microbial community of the root/rockwool underwent a shift influenced by time (crop stage of growth) then by biochar treatments. Moreover, solid biochar treatment reduced total bacteria and archaea populations at the end of crop cycle. About Nitrogen cycling bacteria, they were differently affected by biochar treatments: N-fixing and denitrifiers harboring NosZ gene decreased at t2 when solid biochar was added, while ammonia-oxidizing bacteria and denitrifiers harboring NirK gene were not affected by any of the biochar treatments.
Conclusions:

- Application of biochar positively influenced some quality features of cherry tomato.
- Same treatments were responsible for a general shift in bacterial population and consistent reduction of total bacteria and archaea, so as nitrogen-fixing and (partially) denitrifying bacteria.
- Biochar may have released chemical compounds that directly affected the root microbiota and might be detrimental for the plant if at higher concentration but, at low dose, exerted a stimulating effect on the ripening stage, allowing increased accumulation of lycopene and vitamin C.
- Further analyses on a larger scale are needed to clearly assess direct and indirect biochar effects on crop productivity.

Key words: cherry tomatoes, cultivation, soilless, microbial, chemical parameters, biochar

THE EFFECT OF 1-MCP TREATMENT ON FRUIT QUALITY OF 'CONFERENCE' PEAR

Krzysztof P. Rutkowski, Anna Skorupińska, Aneta Matulska, Zbigniew B. Jóźwiak, Anna Ciecierska

Department of Fruit and Vegetable Storage and Processing, Research Institute of Horticulture, Konstytucji 3 Maja 1/3 str., Skierniewice, Poland
e-mail: anna.skorupinska@inhort.pl

Effect of 1-MCP treatment on selected quality parameters of 'Conference' pears stored in regular air and controlled atmosphere conditions was evaluated. Results from two storage seasons (2015/2016 and 2016/2017) were presented. After harvest and cooling down, fruits were treated with 1-MCP in concentrations of 0.312 ppm and 0.625 ppm for 24 hours. Treated and untreated pears were stored for 2 and 5 months in cold storage rooms at 0.5 °C under regular air (RA) and controlled atmosphere (CA) conditions with 1.5% O2 and 0.7% CO2. After storage and additional 1 and 7 days of shelf life at 18°C, flesh firmness (FF), total soluble solids (TSS), and titratable acidity (TA) were recorded.
After 2 months of storage in RA and CA conditions, FF (after 1 day of shelf life) was similar for untreated and 1-MCP treated pears, but after 7 days of shelf life, the softening was inhibited, but uneven, in 1-MCP treated fruits. In the season 2016/2017, after 5 months of storage, untreated pears and treated with 1-MCP (regardless of concentration) softened similarly within 7 days of shelf life. In the season 2015/2016, softening of fruits treated with 1-MCP was uneven, especially those stored in CA. There was no effect of 1-MCP on soluble solids content and titratable acidity in 'Conference' pears stored in RA and CA conditions.

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Key words: controlled atmosphere, regular atmosphere, flesh firmness, soluble solids, titratable acidity

THE EFFECT OF FRAGMENTATION AND PACKAGING ON SELECTED CHEMICAL AND MICROBIOLOGICAL PARAMETERS OF DRIED PARSLEY LEAVES

Kalina Sikorska-Zimny[1,2], Karolina Wójcicka [1*], Anita Rochmińska[1*], Paweł Lisiecki[3]

[1] Institute of Health Science, Faculty of Natural and Technical Sciences, State College of Applied Sciences in Skierniewice, Poland
[2] Fruit and Vegetables Storage and Processing Department, Research Institute of Horticulture, Konstytucji 3 Maja 1/3, 96-100 Skierniewice, Poland
[3] Department of Pharmaceutical Microbiology and Microbiological Diagnostics, Medical University of Łódź, Pomorska 137, 90-235 Poland
* Bachelor Students; Work conducted during the subject "technology of herbs and spices", of 2nd year of dietitians majority.
e-mail: kalina.sikorska@inhort.pl

Parsley leaves (*Petroselinum crispum*) have long been known for their organoleptic properties. They are widely used in cuisine all over the world but also as medicine. Leaves of parsley are used in both fresh and dried form.
The presented work assessed if the method of fragmentation of parsley leaves (whole leave, and leaves pieces) and packaging (PE and x-tend foils) influences the content of selected chemical compounds and the microbiological assessment of the product. For this purpose, the particulate material (2 fractions) was dried, packaged (PE and x-tend bags) and analyzed.
After 3 weeks of storage there have been observed higher content of vitamin C and reducing sugars in PE foils-whole leaves (1.65 mg/100 g DW; 3.47% DW, respectively), highest total sugar were determined in x-tend foil with whole leaves pieces (6.75% DW). It was visible that higher vitamin C content was connected with bigger fraction of leaves, while reducing sugars content with type of packaging.
Microbial analysis pointed lowest bacteria content for parsley leaves pieces in x-tend, and highest for PE packaging of leaves pieces (5.65 x 103 and 15.71 x 103, respectively). There were no fungus colony observed in x-tend packaging while in PE foils there were 5,1 x 103 and 3,00 x 103, for parsley whole and pieces of leaves (respectively).

Key words: parsley leaves, drying, microbial analysis, chemical parameters, storage

POLYSACCHARIDE-BASED EDIBLE COATINGS AMENDED WITH SODIUM BENZOATE OR POTASSIUM SORBATE TO REDUCE PENICILLIUM DECAY AND MAINTAIN POSTHARVEST QUALITY OF 'ORRI' MANDARINS

Lourdes Soto-Muñoz[1, 2], L. Palou[2], V. Taberner[2], Maria B. Pérez-Gago[2]

[1] Programa de Posgrado en Ciencia y Tecnología Ambiental (MCTA), Facultad de Química, Universidad Autónoma de Querétaro. Cerro de las Campanas s/n, Col. Las Campanas, C. P. 76010. Santiago de Querétaro, Querétaro, México.
[2] Centro de Tecnología Poscosecha (CTP), Instituto Valenciano Investigaciones Agrarias (IVIA), Ctra. CV-315, km 10.7, 46113 Moncada, Valencia, España.
e-mail: soto_lou@externos.gva.es

Edible composite coatings based on arabic gum (AG), hydroxypropyl methylcellulose (HPMC) or potato starch (S) as biopolymers, in combination with beeswax (BW), glyceryl monostearate (GME) or carnauba wax (CW) as hydrophobic components were formulated with two food preservatives with antifungal properties: sodium benzoate (SB, 2% w/w) and potassium sorbate (PS, 2% w/w). The effects of coating formulation (including polymer, lipid, and antimicrobial agent type) on the quality of 'Orri' mandarins were evaluated. Subsequently, selected edible coatings were assessed for the control of citrus green and blue molds on mandarins artificially inoculated with *Penicillium digitatum* and *Penicillium italicum*, respectively, and incubated at 20°C. AG-based emulsions showed high viscosity values (145.31-448.49 mPa) and these coatings increased weight loss of the mandarins stored at 20°C for 14 days. The formulations based on HPMC-BW and HPMC-GME proved to be stable and had a viscosity of 18.35 and 58.91 mPa, respectively. Their application as coatings reduced of the mandarins by approximately 20% at the end of the storage, but the visual appearance of coated fruits was less glossy than that of control fruits (uncoated). Among the S-based coatings, the combination with GME formed low viscosity emulsions of 27.7 mPa and the coating significantly reduced weight loss, without adversely affecting the appearance of the fruit. For all coatings, the addition of SP significantly increased the weight loss of the mandarins. Overall, the S-GME coating containing 2% SB was the most effective to control Penicillium decay and reduced disease incidence (percentage of infected fruit) and severity (lesion diameter) by 40% and 35%, respectively. It also significantly reduced weight loss of 'Orri' mandarins during storage at 20°C, showing its potential for industrial postharvest preservation of 'Orri' mandarin. Further studies are needed to evaluate the effects of this coating on the development of Penicillium molds and the physico-chemical and sensory quality of citrus fruit during long-term cold storage.

Key words: food preservatives, citrus, *Penicillium digitatum*, *Penicillium italicum*

OPTIMAL STORAGE TECHNOLOGIES FOR ORGANIC APPLES BASED ON QUALITY PARAMETERS

Andreea Stan, Mihaela Zugravu, Carmen Constantin, Mihai Frîncu, Aurora Dobrin, Violeta Alexandra Ion, Andrei Moț, Andrei Petre, Roxana Ciceoi, Ioana Bezdadea-Cătuneanu, Liliana Bădulescu

Research Center for Studies of Food Quality and Agricultural Products, University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăşti Boulevard, Bucharest, Romania
e-mail: andreea_stan88@yahoo.com

Nowadays, the consumer demand for organic fresh fruits with better nutritional quality and the market pressure for a prolonged shelf life are growing and for this reason the improved storage conditions and technologies are important and becomes highly relevant. The controlled atmosphere represent an efficient technology used for fruits and vegetables storage which is accepted also in organic system when gases like O_2, CO_2 and N_2 are used. In addition, controlled temperature and humidity enhance the benefits of long-term storage and better shelf life, especially for organic fruits. Apples represent one of the most common organic fruits which require long-term storage. Considering these, the aim of this work was to establish the optimal storage technologies for organic apples based on quality parameters. Two apple varieties like Rubinola and Topaz, grown in the experimental orchard of University of Agronomic Sciences and Veterinary Medicine of Bucharest were harvested, stored and monitored for six months. The storage technologies applied were normal atmosphere, with 1°C and 95% RH (for 2 months), combined with controlled atmosphere (for another 4 months) with 1°C, 95% RH, 3% O_2 and two different CO_2 concentrations (5%, respectively 10%). The quality parameters of apples consist in analisys of caliber, firmness, total soluble solids (TSS), dry matter content (DM%), pH, total titratable acidity (TAA), ascorbic acid content, total polyphenol and total anthocyanin content. Chromatographic separation of ascorbic acid was realised with Agilent XDB-C18 (4.6 x 50 mm, 5 µm) column. When results of ascorbic acid content from initial moment were compared with those obtained after 6 months of storage in normal conditions Rubinola variety registred a decrease with 36%, in 5% CO_2 – 59% and in 10% CO_2 – 38%. In normal condition storage the Topaz variety registred decreases with 50%, for 5% CO_2 – 80% and for 10% CO_2 – 86%. For all apple samples in all storage conditions, the total polyphenolic content registred increases during 6 months storage. In conclusion, the results presented above suggest that further studies and trials are required.

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Key words: organic, cold storage, oxygen, carbon dioxide, apples

THE CONTENT OF BIOACTIVE COMPOUNDS OF PUMPKIN CULTIVARS

Justyna Szwejda-Grzybowska, Monika Mieszczakowska-Frąc

Research Institute of Horticulture, Department of Fruits and Vegetables Processing and Quality Evaluation, Konstytucji 3 Maja 1/3, Skierniewice, Poland
e-mail: justyna.grzybowska@inhort.pl

Pumpkin (*Cucurbita maxima* L.) is a gourd squash of the genus Cucurbita in the family Cucurbitaceae and is widely grown and consumed in many countries around the world. It is appreciated by consumers for its soft and sweet taste and its high nutritive value, it is an especially excellent source of carotenoids such as β-carotene, lutein, and zeaxanthin. The subject of this study was to determine the bioactive compounds of six cultivars of pumpkin: 'Hokkaido', 'Ambar', 'Amazonka', 'Justynka', 'Bambino', 'Muskat'. The contents of ascorbic acid, total polyphenols and total carotenoids were determined in the fruits of pumpkin. The ascorbic acid was determined by chromatographic method and total polyphenols by spectrophotometric method. The carotenoids separation was performed on an Agilent Techonolgies 1200 Series liquid chromatograph equipped with a Kinetex C18 column. Seven carotenoids have been identified in fruits of pumpkin (β-carotene, cis-β-carotene, α-carotene, lutein, zeaxanthin, capsantine, violaxanthin). The highest content of total carotenoids were found for pumpkin fruits 'Amazonka' (224.4 mg/kg f.m.) and the lowest content in 'Ambar' (66.3 mg/kg f.m.). The content of ascorbic acid ranged from 2.9 to 173.9 mg/kg and total polyphenols from 230.1 to 511.7 mg/kg f.m. in different cultivars of pumpkin.

Key words: pumpkin, carotenoids, polyphenols, ascorbic acid

REASONS FOR THE APPEARANCE OF SKIN BURNING IN 'GALA' APPLES FROM REGULAR AIR STORAGE

Elke Weinmann, Dominikus Kittemann

Department of Horticulture, Weihenstephan-Triesdorf University of Applied Sciences, Am Staudengarten 7, 85354 Freising, Germany
e-mail: elke.weinmann@hswt.de

During recent years Gala apples from regular air storage in Germany have shown skin burning symptoms, a physiological disorder which so far has only been known for different varieties in fruit from controlled atmosphere and which has been mainly related to increase CO_2-levels in the atmosphere. In order to investigate the reasons for the disorder and the sensitivity of the fruit, a 2-year trial was carried out at the Weihenstephan-Triesdorf University of Applied Sciences in Freising. The apples were harvested early and late (maturity index: 0,11 and 0,09 (2017)/ 0,1 and 0,07 (2018)), at both maturity stages half of the batch with low and half with high percentage of blush colour. The parameters for maturity and quality (firmness [kg/cm²], starch degradation [1-10], total soluble solids [°Brix], titratable acidity [g/l] and skin colour [°h] were measured before storage and the percentage of blush colour was estimated. Within one week after harvest, half of the apples from each harvest date and colour-group was treated with 1-MCP (625ppb). After 29 (2017) and 26 weeks (2018) of storage and a following shelf-life period of 1 week at 20°C the percentage of fruit with skin burning symptoms was evaluated in all treatments. Results show, that an earlier harvest date as well as poor blush colour led to a higher percentage of fruit with skin burning symptoms. In addition, 1-MCP treatment increased the sensitivity of the fruit for the disorder. For Gala apples from the Lake Constance region, an optimal harvest date in combination with good blush colour seem to be important factors in reducing skin burning during cold storage. Especially for early harvested fruit with poor colouring 1-MCP can increase the disorder.

Key words: skin burning, air storage, early harvest, late harvest, blush colour, 1-MCP, Gala apples