InHort
SKIERNIEWICE
RESEARCH INSTITUTE OF HORTICULTURE

3rd International Conference

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

March 23-25, 2014, Skierniewice, Poland

PROGRAMME & BOOK OF ABSTRACTS

POLSKIE TOWARZYSTWO NAUK OGRODNICZYCH

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POLSKA AKADEMIA NAUK

3rd International Conference

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

March 23-25, 2014, Skierniewice, Poland

Organized by

Research Institute of Horticulture

in cooperation with

Polish Academy of Sciences - Storage Section of the Committee of Horticultural Sciences

and

EUFRIN - Fruit Quality Working Group

under the auspices of:

Polish Academy of Sciences and
Polish Society for Horticultural Science

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Program of the Conference

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

Sunday 23rd of March 2014

19:00 - Welcome Reception (with sightseeing of the palace)

Palace of the Research Institute of Horticulture (InHort), Konstytucji 3 Maja 1/3 Str.

Monday 24th of March 2014

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

7:30 – 8:40	**Registration of Conference participants**
8:40 – 9:00	**Opening Ceremony of the Conference** (Chairman of the Conference, Director of the Research Institute of Horticulture, Chairman of Committee of Horticultural Sciences of the Polish Academy of Sciences, Chairman of the QUAFETY project, Chairman of the EUFRIN Postharvest Working Group)
9:00 – 10:00	**Session I "QUAFETY" – Chairman: Franciszek Adamicki (Poland)**
9:00 – 9:30	**Giancarlo Colelli** (Italy) - **Invited Speaker** A state of the art on quality and safety of fresh-cut products through the EC-funded R&D Project "QUAFETY"
9:30 – 9:45	**Maria Grzegorzewska** (Poland) The effect of hot water treatment on durability of Chinese cabbage
9:45 – 10:00	**Periklis Tzamalis** (Greece) Development of a diagnostic instrument for evaluation of food quality and safety management systems
10:00 – 10:15	***Coffee break***
10:15 – 11:15	**Session II – Chairman: Giancarlo Colelli (Italy)**
10:15 – 10:30	**Manuela Pintado** (Portugal) Impact of processing and storage on nutritional and functional properties of strawberry

10:30 – 10:45	**Natasha Spadafora** (UK) Evaluation of Volatile Organic Compounds in Rocket leaf for non-destructive analysis of post-harvest quality
10:45 – 11:00	**Marina Cavaiuolo** (Italy) Isolation of molecular markers for the evaluation of quality in pre-harvest and post-harvest stages in rocket and melon
11:00 – 11:15	**Victor Rodov** (Israel) Testing suitability of melon genotypes for fresh-cut processing
11:15 – 11:30	***Coffee break***
11:30 – 13:00	**Session III – Chairman: Elazar Fallik (Israel)**
11:30 – 11:45	**Jan Skrzyński** (Poland) The effect of hot water treatments on quality parameters of 'Golden Delicious' apples
11:45 – 12:00	**Zarko Kevresan** (Serbia) Water spraying of raspberries as tool for fresh produce shelf life extension
12:00 – 12:15	**Werner Herppich** (Germany) Comparison of the efficacy of recent sanitation techniques for safety and quality of fresh white asparagus spears
12:15 – 12:30	**Deborah Rees** (UK) Ethylene and Microbial Hotspots in the UK fresh produce supply chain
12:30 – 12:45	**Eivind Vangdal** (Norway) DA-meter to measure maturity stage at harvest and storability in plums (*Prunus domestica* L.)
12:45 – 13:00	**Jasna Mastilovic** (Serbia) Postharvest classification for uniform ripening of tomato picked in early ripening stages
13:00 – 13:30	**Short discussion, taking a photograph of the Conference participants and moving to another building (Reymonta 18 Str. - walking distance)**
13:30 – 15:00	**Poster hanging and *Lunch*** (Reymonta 18 Str.)
15:00 – 16:00	**Bus transfer to ROJA – Group of Fruit Producers** (Address: Regnów 50, 96-232 Regnów)
16:00 – 18:00	**Session IV – Innovative storage technology – in practice (ROJA)**
18:00 – 19:00	**Bus transfer to Skierniewice**
20:00 – TBA	***Official Dinner*** ("Dworek" Hotel-Restaurant, Piłsudskiego 24 Str.)

Tuesday 25th of March 2014

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

8:00 – 9:15	**Session V – Chairman: Sirichai Kanlayanarat (Thailand)**
8:00 – 8:30	**Elazar Fallik** (Israel) - **Invited Speaker** Pre- and postharvest practices may influence pepper fruits after prolonged storage
8:30 – 8:45	**Katarzyna Mazur** (Poland) The influence of pre- and postharvest factors on chemical compounds in 'cherry' tomato fruits
8:45 – 9:00	**Aleksij Poliakov** (Russia) Production of winter garlic seeds under different ways and periods of harvesting
9:00 – 9:15	**Aleksandra Połubok** (Poland) Determination of oleanolic acid and ursolic acid in the apple peel by HPLC method
9:15 – 9:30	***Coffee break***
9:30 – 10:45	**Session VI – Chairman: Aleksij Poliakov (Russia)**
9:30 – 9:45	**Jan Blažek** (Czech Republic) Suitability of new apple cultivars from Holovousy for long time storing in ULO
9:45 – 10:00	**Giulia Bianci** (Italy) Aroma quality of wild and cultivated strawberries (*Fragaria* spp.) in relation to the flavour-related gene expression
10:00 – 10:15	**Dorota Konopacka** (Poland) Quality potential of some new pear cultivars – how to obtain fruit of the best sensory characteristics?
10:15 – 10:30	**Anna Skorupińska** (Poland) Fruit quality of some Asian pear cultivars grown in Poland
10:30 – 10:45	**Sirichai Kanlayanarat** (Thailand) Quality Management of 'Kluai Khai' Banana in Supply Chains to Meet the Requirement for Exporting Market
10:45 – 11:00	***Coffee break***

11:00 – 12:30	**Session VII – Chairman: Jan Skrzyński (Poland)**
11:00 – 11:15	**Richard Colgan** (UK) Prospects for modulating storage temperature and moisture loss in apple and pear storage
11:15 – 11:30	**Angelo Zanella** (Italy) Benefits in apple fruit firmness retention after harvest achieved due to SmartFresh (1-MCP) treatment or Dynamic Controlled Atmosphere storage by means of chlorophyll fluorescence (DCA-CF)
11:30 – 11:45	**Krzysztof Rutkowski** (Poland) The influence of harvest date, SmartFresh (1-MCP) treatment and storage conditions on quality of 'Shampion' apples
11:45 – 12:00	**Zbigniew Jóźwiak** (Poland) On site measurement of oxygen concentration in chlorophyll fluorescence based Dynamic Controlled Atmosphere storage
12:00 – 12:15	**Ina Alsina** (Latvia) The effect of light spectrum on the content of pigments in *Solanaceae* vegetables
12:15 – 12:30	**Elazar Fallik** (Israel) Pearl shade net improving quality traits in pepper after harvest
12:30 – 13:00	**Short discussion and moving to another building (Reymonta 18 Str. - walking distance)**
13:00 – 14:45	***Lunch* & Poster Session** (Reymonta 18 Str.)
14:45 – 15:00	**Change a building (Pomologiczna 18 Str. - walking distance)**
15:00 – 15:30	**Summary of the Poster Session, Discussion and Closing Ceremony** (Main building of the Pomology Division of InHort, Pomologiczna 18 Str.)
15:30 – 15:45	***Coffee break***
15:45 – TBA	**EUFRIN meeting (Main building of the Pomology Division of InHort, Pomologiczna 18 Str.)**

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ABSTRACTS OF ORAL PRESENTATIONS

A STATE OF THE ART ON QUALITY AND SAFETY OF FRESH-CUT PRODUCTS THROUGH THE EC-FUNDED R&D PROJECT QUAFETY

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Ready-to-use fruits and vegetables are having increasing success on the market. These products meet new consumer's demands for healthy, palatable and easy to prepare plant food, which retains its value as a source of vitamins, fiber and micronutrients. However these products deteriorate faster than the correspondent intact produce. This is a direct result of the wounding associated with processing, which leads to a number of physical and physiological changes affecting the viability and quality of the produce. The visual symptoms of deterioration of fresh-cut produce include flaccidity from loss of water, and changes in color (especially increased oxidative browning at the cut surfaces). Nutrient and aroma losses may also be accelerated when plant tissues are wounded. Wounding plant tissues makes them more susceptible to attack by plant pathogenic microorganisms and possibly more conducive to survival and growth of food poisoning microorganisms. Preparation of fresh-cut produce does not include a “killing step”, or a treatment which determines a negligible final microbial count; in addition they are constituted by living cell tissue, rapidly metabolizing, especially when peeled and cut in portions for higher convenience: quality attributes degrade very fast and shelf life is often a matter of days. For all these reasons fresh-cut produce represents a very interesting system where the need of improvements in terms of safety & quality is of paramount importance. Project QUAFETY (Comprehensive Approach to Enhance Quality & Safety of Ready-to-Eat Fresh Products), funded by the EC through the 7th Framework Program, aims to improve safety and quality of RTC fresh produce throughout the whole chain by developing new predictive and probabilistic models and decision-making tools, by exploring rapid and non-destructive methods for quality evaluation and prediction, and by experimenting novel technologies, in order to quantify and manage spoilage and pathogen microorganisms, minimize risks to consumers, and preserve quality. Officially started on January 2012, QUAFETY counts 14 partners, from 7 Countries (Italy, Poland, Greece, Netherlands, United Kingdom, Israel, and Portugal) including 6 SMEs, 2 public research Institutes and 6 Universities, assorted in terms of scientific and technological expertise. Main findings at Project midterm will be presented as well as main dissemination initiatives to potential users.

Acknowledgements: the research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement no. 289719 (QUAFETY Project).

THE EFFECT OF HOT WATER TREATMENT ON DURABILITY OF CHINESE CABBAGE

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The study was carried out on the Chinese cabbage (*Brassica rapa* L *var. pekinensis*) cv. 'Bilko'. The plants material was bought from a producer near Skierniewice. Whole heads were kept at temperature of 0-1°C. Immediately before the start of the experience, damaged leaves were removed and cabbage cut into strips with a width of 1.0–1.5 cm. Fresh-cut leaves were then treated by dipping in water bath with temperature ranging from 38–57°C for time periods ranging from 3 seconds to 20 minutes. After treatment, cut vegetables were drained, cooled to the same temperature and packaged. In the first two experiments the cut leaves (150 g) were packaged into plastic bags (20 x 20 cm) with perforation (10 holes of 0.04cm in diameter),while for other three experiments cut leaves were placed into polystyrene foam trays covered by PE film in crate. The storage temperatures were: 0-1°C, 5°C and 15°C. Quality assessments were done every two days. The first symptom of Chinese cabbage senescence during storage was browning of cut surface. The first browning was visible in the place of the cross section of vascular bundles and next on the whole edges of cabbage pieces. Some time later, the rotting spots have appeared on the fresh-cut cabbage. The dipping in water bath of temperature 53°C – 56°C during minimum 3 second had an influence on browning retardation as well as on maintaining better quality compared to non-treated cabbage. The storage temperature significantly influenced quality of fresh cut cabbage. The best quality was maintained at temperature 0-1°C, while it was a little worse at 5°C,and evidently the worst condition was at room temperature (15°C).Hot water treatment did not influenced the growth of microorganisms with exception of *Enterobacteria*ce and fungi. In case of *Pseudomonas* and coliforms the hot water treatment as well as rinsing in tap water contributed to their larger development especially at room temperature (15°C). *Salmonella* and *Listeria* were not detected before and after storage. It was found that after short storage of treated cabbage (both in hot and tap water) the content of vitamin C, phenols as well as antiradical activity were lower than in control. After two days at room temperature and after 5 days at 0-1°C the non-treated cabbage contained significantly more nitrates than cabbage treated with hot water.

This study is funding from the European Union (FP7/2007-2013) GA 289719 (QUAFETY).

DEVELOPMENT OF A DIAGNOSTIC INSTRUMENT FOR EVALUATION OF FOOD QUALITY AND SAFETY MANAGEMENT SYSTEMS

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The objective of the present study was to develop a validated diagnostic instrument for the assessment of the Quality Management System / Food Safety Management System (QMS/FSMS) applied in SMEs of the ready to eat fresh products sector. In order to achieve the objective a conceptual research model indicating critical technological and managerial elements as well as influencing conditions on the production – processing chain (indicators)- was developed. Then an initial operational diagnostic instrument (questionnaire) was constructed based on the conceptual research model for the assessment of the QMS/FSMS. The questionnaire, after validation, was sent to SME to be filled in. After applying principal component analysis the components were extracted to provide a score for the performance of QMS/FSMS. The vast majority of the SME has implemented a QMS/ FSMS. The data analysis showed that one factor would be sufficient for the final assessment of the performance of QMS/ FSMS. The use of additional factors does not differentiate significantly the best practice score. The diagnostic instrument could be used as an assessment tool for internal or external auditing purposes and it will be a key part of the food safety and quality management system.

Acknowledgment

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n. 289719 (Project QUAFETY).

IMPACT OF PROCESSING AND STORAGE ON NUTRITIONAL AND FUNCTIONAL PROPERTIES OF STRAWBERRY

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Strawberries are a source of biologically active compounds such as vitamin C, flavonoids, namely anthocyanins, and other polyphenols. The consumption of strawberries has been associated to human health benefits due to their antioxidant, anticancer, anti-inflammatory and anti-neurodegenerative properties. Processing and storage factors affecting strawberry composition and loss of nutritional quality may result in the ingestion of nutritionally inferior fruit. Levels of biologically active compounds in strawberries vary during postharvest handling, with processing inducing a number of physiological responses with impact on nutritional quality. This study surveys processing and packaging effects on strawberry biologically active compounds and emphasize how processing technologies impact these compounds and resultant antioxidant activity. The postharvest handling system and processing line of a fresh-cut fruits enterprise was studied, collecting replicated samples at each step of the production of fresh-cut strawberries (at fruit reception, after calyxe's removal, after decontamination and after cutting). Furthermore, in order to evaluate the effect of cutting and package type on strawberries functional properties throughout storage, fresh-cut strawberries were packaged in 236 mL clamshells or 78 mL packages heat sealed with a Resinex 259 film, stored at 5 °C, and assessed on days 1, 2, 5 and 7 of storage. All samples were frozen with liquid nitrogen and stored at -80 °C until characterization. Total antioxidant activity was assessed by the ABTS method, total phenolics by Folin Ciocalteau´s method and anthocyanins and other phenolic compounds and ascorbic acid were analyzed by high performance liquid chromatography (HPLC-DAD).
As processing steps advanced, from reception to cutting, strawberries antioxidant capacity increased. Whole and fresh-cut strawberries showed similar total phenolic compounds and total anthocyanins contents, while decontaminated strawberries showed lower values for these compounds. Epicatechin, rutin and ellagic acid were affected mainly after calyx removal and cutting and the anthocyanin pelargonidin-3-glucoside changed after decontamination and cutting phases.
Cutting and package type also affected phytochemical quality of strawberries. Fruit cutting significantly increased total phenolic compounds, with fresh-cut strawberries stored in clamshells showing the highest values from day 2 to day 5 of storage. A significant effect of package type on fresh-cut strawberries anthocyanins content was observed, with whole strawberries stored in clamshells showing the highest values. Although the effects of cutting and package type were not consistent throughout storage, cutting led to the decrease of epicatechin, rutin and cyanidine-3-glucoside contents. In fresh-cut strawberries catechin, epicatechin and rutin levels were better maintained in filmed packages while the anthocyanin pelargonidin-3-glucoside was better preserved in clamshell packages.

EVALUATION OF VOLATILE ORGANIC COMPOUNDS IN ROCKET LEAF FOR NON-DESTRUCTIVE ANALYSIS OF POST-HARVEST QUALITY

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Aroma is an important component of vegetables. Volatile organic compounds (VOCs) specifically sulphur-containing VOCs released by wild rocket (*Diplotaxis tenuifolia*) leaves give rocket a pungent odour, and peppery taste. These compounds are part of a defence mechanism against predators and are synthesized by the plants upon tissue damage. Leaf damage during industrial processing, storage and stress conditions can affect the aroma of rocket. The objective of this study was to analyse volatile organic compounds (VOCs), with a view to using VOCs as non-destructive markers for quality and safety in rocket salads. Initially, leaves from a commercial variety of rocket (*Diplotaxis tenuifolia*) were wounded and VOCs emitted into the headspace were sampled on thermal desorption sampling tubes. Analysis using Thermal desorption gas chromatography time-of-flight mass spectrometry (TD-GC-TOF-MS) allowed determination of a total of 57 compounds in the samples. Abundance of these compounds was found to relate to presence and degree of wounding. We also investigated the influence of storage temperature and time on composition of VOCs in the head-space. We were able to identify the major volatile compounds associated with rocket aroma and show significant changes in the overall VOC profile during storage. We were also able to separate the VOC profiles from the different temperatures. Overall our results indicate that VOCs may be useful markers as indicators of the effects of these parameters on quality.

ISOLATION OF MOLECULAR MARKERS FOR THE EVALUATION OF QUALITY IN PRE-HARVEST AND POST-HARVEST STAGES IN ROCKET AND MELON

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The development of rapid, reliable and specific methods are necessary for the evaluation of quality in ready-to-eat vegetables during the production chain from pre- to post-harvest and storage stages. Since the quality after harvest cannot be improved but only preserved, quality markers must be isolated in order to identify the minimum variation of quality already after the first day of storage. Our objective was to identify stress responsive genes that are associated with quality losses and can be used as quality markers in both rocket (*Diplotaxis tenuifolia* L.) and melon (*Cucumis melo* L.) fresh cut produce.
Quality markers were isolated by transcriptome sequencing (RNA-Seq) in rocket. Rocket plants were grown hydroponically in controlled growth chambers for 3 weeks prior to apply 24 hours stresses. In pre-harvest were imposed salinity (200 mM NaCl), heat radical stress (40°C), nitrate deficiency (absence of NH_4^+/NO_3^-), while in post-harvest were imposed chilling (4°C), wounding, dark and water stress. Total RNA extracted from stressed and control plants was sequenced with a two paired-end Illumina sequencing approach. 10 genes commonly up-regulated in all the stresses and associated with senescence, degenerative processes and quality losses were selected as putative markers. In melon the molecular markers were identified by searching for the homologous genes of the rocket putative markers. The expression levels of these quality markers was analyzed by quantitative Real Time PCR (qRT-PCR) at different time points from harvest to 14 days of storage at 20°C and 4°C in rocket and melon produce. In both species all genes increased their expression soon after harvest indicating that these markers will be useful to evaluate the quality of the produce.

TESTING SUITABILITY OF MELON GENOTYPES FOR FRESH-CUT PROCESSING

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The melon species *Cucumis melo* L. is subdivided into varieties/horticultural groups based on their fruit characteristics. *C. melo* var. *cantalupensis* typically has medium-size climacteric fruit with netted rind and distinct aroma. *C. melo* var. *inodorus* is characterized by large-sized melons with non-aromatic, non-climacteric and long-stored fruits with thick smooth or wrinkled rind. Industry has special demands to melons intended for fresh-cut processing. The fruit should have firm pulp texture, stable post-cut quality, high product/waste ratio, and allow efficient decontamination. It should be compatible with other fruit salad ingredients and answer consumer expectations in terms of appearance, flavor and nutritional value. In this work we compared the performance of *inodorus* (Piel de Sapo and Yellow Canary) and *cantalupensis* (Charentais, Galia and Cantaloupe) melon genotypes as raw materials for fresh-cut processing. The fruit were processed at the ARO fresh-cut pilot facility and stored at 5-6°C for three weeks with weekly quality evaluation. The quality assessment included visual examination (pulp color, cut surface quality, "translucency", microbial decay), organoleptic tests (typical aroma, off-odor, typical flavor, off-taste) and instrumental measurements (pulp firmness, soluble solids content). Fresh-cut products of *inodorus* melons had longer shelf-life and underwent less quality changes during storage than those of the *cantalupensis* group. Quality decline in *inodorus* melons was attributed primarily to the changes in cut surface and microbial growth. On the contrary, off-flavor was the major factor of quality decline in most of the *cantalupensis* types. Efficacy of surface decontamination was tested in a separate trial with smooth *inodorus* Yellow Canary and rough-netted cantaloupe melons artificially inoculated with a bacterium *Pseudomonas putida*. After washing with 100 ppm active chlorine solution, the microbial population on smooth melons was 1 log CFU/cm^2 lower than on the rough melon. In addition, big size and oblong shape characteristic to some *inodorus* melons may be advantageous for processing. Examination of various melon genotypes by Einat Food Industry at their commercial fresh-cut fruit facility indicated a new pink-fleshed *inodorus* melon Sorbeto (Catom Seeds) as a promising genotype for processing. The genotype evaluation is ongoing.

THE EFFECT OF HOT WATER TREATMENTS ON QUALITY PARAMETERS OF 'GOLDEN DELICIOUS' APPLES

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'Golden Delicious' apples during storage are among those cultivars which are very susceptible for excessive transpiration (water and weight loss) as well as fungal diseases. In order to optimize storage conditions the effect of additive hot water and time exposure as a bath treatments were studied. Apples were subjected to hot water baths in water of temperatures 45, 50, 52 and 55°C and duration of treatment time was 60, 120, 180 and 240 seconds respectively. Fruits after bath were blast cooled in an cold air blast. Treated apple samples and untreated control were stored normal air cold storage rooms in 2°C. Fruits were analysed after storage for 18 and 25 weeks respectively. Experimental samples were divided into two lots, one for direct after storage assessments and the second one lot of apples were subjected to seven days long shelf life period in room temperature. Fruit weight loss, flesh firmness, total soluble solids (TSS) content, pH, titratable acidity (TA) and TSS to TA ratio were assessed. The incidences of physiological disorders and storage diseases were also evaluated. Hot water treatments did not diminished any quality factors in question, some of them were even better than in comparison to the control sample fruits. However apples subjected to treatments with water of 50-55°C already after storage for 16-18 weeks were affected by notable water loss with decline of turgor in subepidermal layer. The shrivelling symptoms was excessive after 25 weeks and numerous brown skin spots were observed. The apples treated with hot water at 45°C for 60 and 120 seconds were sound. We may conclude that temperature range 45°C and duration bath time not exceeding 120 seconds is the best for 'Golden Delicious' apples. Higher temperature range and duration time impose superficial skin damage due to overheating and epidermal layer of waxes became dissolved.

WATER SPRAYING OF RASPBERRIES AS TOOL FOR FRESH PRODUCE SHELF LIFE EXTENSION

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Serbia is traditionally recognized as exporter of frozen raspberries. Only recently production of raspberries has started to change towards production of fresh raspberries. During this change, introduction of new varieties and new procedures (including irrigation, fertilization, plant protection, etc) was implemented. In relatively short period of time, fresh raspberries reached Serbian market and produced surplus. Existing raspberry storage methods enable shelf life of fresh raspberries of up to three days. Aim of this work was to find the procedure which would enable extension of storage time of fresh raspberries over one week.

Raspberries, variety "Polka" produced in Northern part of Serbia (village Đurđevo) in late August were used for the experiment. Picked raspberries were placed in plastic containers intended for raspberries packaging in two layers. Prior to the storage Raspberries were sprayed with water. Total amount of sprayed water was 1.25 or 0.25 % of raspberries weight per treatment. As control non sprayed containers was used. All containers were stored on 4±1 °C with 95±5 % relative humidity and with constant air circulation.

Weight loss and color were measured every day during the storage. During 8 days of raspberry storage initial difference in weight was diminished while treated fruits kept initial texture. The main problem with which raspberry producers are faced is related to forming of unattractive fruit color shortly after harvest which was diminished in certain storage period according to the sensory evaluation of color and based on obtained L*, a*, b* values measured with Konica Minolta Chromameter CR-400.

COMPARISON OF THE EFFICACY OF RECENT SANITATION TECHNIQUES FOR SAFETY AND QUALITY OF FRESH WHITE ASPARAGUS SPEARS

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In Germany, white asparagus is a very important vegetable. Normally sold fresh, its popularity as a peeled convenience product is currently increasing. A crisp appearance at the point of sale does not indicate about a potential bioburden with phyto or human pathogenic micro organisms. There is a need to develop sustainable and gentle sanitation techniques, which fulfil the high requirements on produce safety. Due to their potential deleterious side effects, chlorine and methyl bromide, still used in many countries, are strictly forbidden in Germany. During a period of seven years, studies were performed to develop an optimal technique to efficiently and gently reduce the microbial load on fresh and lightly processed white asparagus. In many experiments, effects of various sanitizing additives (2.6 and 4.5 ppm ozone; 50 % ethanol; 5 ppm ClO_2) to washing water and of UV-C radiation (254 nm, 1 kJ m^{-2}) on the microbiome of asparagus as well as the impact of the respective treatments on produce quality were investigated. For studies, freshly harvested asparagus was washed, sorted, separated into batches (500 g), treated and then stored at 20 °C in water vapour saturated air for 4 d, with untreated spears as controls. Before storage and on days two and four of storage, samples were analysed for total plate counts (TPC) and amounts of yeasts and moulds. In this presentation, anti microbial efficacy of the different sanitation techniques on TPC, and yeasts and moulds on white asparagus spears, short-term stored at room temperature, will be comparatively evaluated and discussed, and their practical relevance and potential applicability scrutinized.

ETHYLENE AND MICROBIAL HOTSPOTS IN THE UK FRESH PRODUCE SUPPLY CHAIN

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Both ethylene and microbial contamination (in the form of airborne fungal spores), can increase the rate of deterioration of fresh produce. With funding from the Waste Recycling Action Programme (WRAP), the Produce Quality Centre (PQC) carried out a survey of microbial spore counts and ethylene concentrations in the atmosphere at five stages of the supply chain for UK grown produce supplying UK supermarkets. The survey covered short-term storage facilities, packhouses, distribution depots, back of shop store rooms, and retail areas.

Highest values of fungal spore counts (2000-16000 counts m^{-3})were found in packhouses, where increased produce handling led to a greater dispersal of innoculum. In other parts of the supply chain counts were below 2000 counts m^{-3} in more than 90% of cases and never greater than 4000 counts m^{-3}.

Ethylene concentrations within packhouses, distribution depots, back of shop store rooms, and retail areas were below 100 ppb in more than 90% of cases and never greater than 200 ppb. The highest ethylene concentrations were found within storage facilities, where limited air changes in confined spaces led to increased ethylene accumulation with ethylene concentrations between 200 and 600 ppb in 75% of cases, and greater than 600 ppb in 20% of cases were recorded.

Sensitivity to ethylene varies by commodity and maturity, but concentrations as low as 100 ppb have been shown to reduce shelf-life of commodities including broccoli, lettuce, cabbage, strawberry and green vegetables.

Results are reported from subsequent studies which quantified the benefits of scrubbing ethylene from store rooms for sensitive produce such as broccoli.

DA-METER TO MEASURE MATURITY STAGE AT HARVEST AND STORABILITY IN PLUMS (*PRUNUS DOMESTICA* L.)

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The changes during maturation in plums have been monitored by the DA-meter; a portable spectrometer giving an IAD index (index of the absorption difference between 670 and 720nm indicating chlorophyll content). As the DA-meter measurements are non-destructive, the same fruits was measured once a week from 4 weeks prior to estimated harvest date in 5 cultivars in 12 different orchards in different growing areas in Norway.
Even though cultivar differences and biological variation within three and orchard was observed, the IAD-index may give interesting information to the growers and pickers. The possibility to use DA-meter to improve the recommendations for picking dates in plums will be discussed.
Plums of cvs. Reeves and Jubileum were sorted into three groups according to IAD index. Samples of all groups were assessed for quality parameters at harvest and after storage in CA-bags or natural atmosphere at 2 °C for 6 weeks. The samples were divided into two subsamples when they were removed from storage. One subsample was analysed the same day while the other was kept at 20 °C for one week and then analysed to get information about shelflife after storage.
The results of the storage experiments indicate that grading of plums according to IAD-index is interesting in order to decide if plums should be marketed at once or they may be stored with good results.

POSTHARVEST CLASSIFICATION FOR UNIFORM RIPENING OF TOMATO PICKED IN EARLY RIPENING STAGES

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After termination of production season in greenhouses in late autumn considerable quantities of unripe tomato fruits in different ripening stages remain on the plants. Thus at that time greenhouses have at disposal significant quantities of tomato in different ripening stages which ripens unequally in the postharvest period. Multistep segregation of ripe tomato results in large postharvest losses that result in the fact that less than the half of tomato picked in the moment of termination of production season reaches the market.

The possibilities of visual and instrumental classification of tomato immediately after the harvest according to the fruit color and size in order to form uniformly ripening lots was investigated. Tomato varieties Brooklyn, Izmir, Nemo-neta and Kamri produced in greenhouses in late autumn were used for investigation. Fruits were visually classified to green and early breaker maturity stage, while instrumental classification was performed into groups of fruits formed based on the a* value measured in CIEL*a*b* color space with Konica Minolta Chromameter CR-400. Additionally fruits were classified according to their weight into two groups with weight classification criteria set in dependence of variety. Visually and instrumentally classified fruits were stored with constant air circulation under controlled temperature (13 and 18^{o}C) and relative humidity (95±5%) conditions for 30 days.

After each 10 days of storage fruit color, weight and texture properties were measured and sensory evaluation of acceptability of appearance and taste was performed.

Based on obtained results applied classification methods were evaluated regarding the maturation duration and uniformity of fruit maturation within formed lots of fruits with different visually or instrumentally determined color and with different size. Visual classification of fruits resulted in only slight increase of uniformity of fruit maturation within lots, while instrumental classification enabled forming of lots that uniformly matured within time span dependant on fruit initial color after harvest.

PRE- AND POSTHARVEST PRACTICES MAY INFLUENCE PEPPER FRUITS AFTER PROLONGED STORAGE

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The quality of fresh harvested produce can be influenced by factors that include: 1. The variety (genetic background) of the fresh produce; 2. The weather conditions; 3. All pre-harvest treatments and practices; 4. All postharvest treatments and practices; and 5. All of the above.

Sweet bell pepper is one of the most important export commodities in Israel, and during the last 5 years, an average of 135,000 tons of pepper were exported to Europe and North America. Pepper can be stored for 7 to 10 days in cold storage conditions (7 °C) with minor symptoms of physiological and pathological deterioration. With proper pre- and postharvest practices, produce can even be maintained for 2 to 3 weeks.

Over the last decade we explored the influence of genetic background, pre-harvest practices; such as growing condition and irrigation, and postharvest practices. Postharvest practices that extend storability and marketability of fresh produce include: selecting proper maturity stage for harvest, physical and quarantine treatments, and cold chain management during storage and transport.

The overall quality of red pepper cultivars was significantly better than the yellow pepper cultivars, especially during the end of the export season after prolonged storage and shelf life simulation. In preharvest scenarios, a 30% reduction in irrigation benefited fruit quality and reduced water use. Pepper grown under Pearl net was significantly better in quality than pepper grown under black commercial shade net. Fruit harvested at 75-80% color maintained better quality during storage. During postharvest, washing, while brushing (HWRB) fruit at 55 °C for about 15 s., was significant in maintaining fruit quality. A combination of physical treatment (HWRB) with bagging was found to maintain fruit quality at 1.5 °C, as a quarantine treatment. Breaking the cold chain, even for 2 h during transport and storage, reduced fruit quality after prolonged storage.

THE INFLUENCE OF PRE- AND POSTHARVEST FACTORS ON CHEMICAL COMPOUNDS IN 'CHERRY' TOMATO FRUITS

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The aim of the study was to determine the effect of growing medium and 1-MCP treatment on chemical compounds of 'Dasher F1' 'cherry' tomatoes (*Solanum lycopersicum* L. var. *cerasiforme*) during storage. The experiment was conducted in 2011. Plants were grown in coconut fibre slabs and mineral wool slabs. Fruits were harvested in June at pink and light-red ripening stages (3rd and 5th stage, USDA standard chart), treated with two concentration of 1-MCP (1 ppm for 12 hours at 18 °C) and stored for two and three weeks at 12 °C. Directly after harvest and after storage time chemical analyses were carried out. There were determined: total carotenoids content, particular carotenoids content by HPLC as well as total content of phenolic compounds. Lycopene content in fresh fruits was not dependent on growing medium. Higher content of this compound was determined in fruits harvested in 5th stage of maturity. Fruits stored after treatment with 1-MCP had lower content of carotenoids than fruits from control combination. The content of total phenolic compounds did not differ between fruits from two types of growing medium. The 1-MCP using caused slower increase of carotenoids content during storage time.

Key words: carotenoids, greenhouse, HPLC

PRODUCTION OF WINTER GARLIC SEEDS UNDER DIFFERENT WAYS AND PERIODS OF HARVESTING

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The big need in garlic is connected with its use as food and as raw material for pharmaceutical industry. During the last period new discoveries of properties of the garlic connection with its importance for treatment of a number of diseases including oncological onece, production and consumption of this culture considerably increased and now in the world production makes about 24 million tons, including China, share of it consested of more than 80%.

Unfortunately, in Russia production of garlic remains at a low level. Total yield makes about 237 thousand tons or about 1% of world production. Under it yieldness of garlic in Russia consested of 8.7 t/ha, while in the world – 16.7 t/ha, and China – 23.1 t/ha (FAOSTAT, 2012). For the last three years in a domestic Russian garlic production the positive tendency was observed which shows the reduction of import of the Chinese, Egyptian and Iranian garlic: from 11.7 thousand tons in 2011 to 6.7 thousand tons — in the 2012th. In Russia some large producers of this culture started developing successfully: Group of Companies “Zelenaya dolina” (Belgorod) and Association “Russian Garlic” (Voronezh). Many farmers and homestead farms became to be interested in production of this vegetable crop.

The carried out investigations show that removal of arrows together with bulbs in optimal period for garlic harvesting can be considered as the most perspective way of garlic propagation because mass of bulbs from a plant (10.8 g) is significantly lower in compare with the plants harvested with a delay in two weeks (11.2 g). In the same time the risk of deterioration of quality of bulbs decreases significantly.

Key words: winter garlic, bulb, tooth, term of harvesting

DETERMINATION OF OLEANOLIC ACID AND URSOLIC ACID IN THE APPLE PEEL BY HPLC METHOD

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Triterpenes are pentacyclic compounds with 30 carbon skeleton which is composed of isoprene units and belongs to the group of secondary plant metabolites. Two of them - oleanolic acid (OA) and ursolic acid (UA) are widespread in many plant species. These compounds are mainly found in the stem bark or leaf and fruit waxes. The profile of triterpenes depends on the kind of plant e.g. oleanolic acid was observed in the olive fruits and leaves and clove flowers while the ursolic acid dominates in apple's skin. Rosemary leaves are rich in both triterpenes. Those compounds have protective effect against cardiovascular or hyperlipidemic diseases and potential antidiabetic properties, especially in reducing the symptoms of type II diabetes.

In the experiments fruits were peeled using vegetable peeler. Then the peel was freeze-dried, ground in dry ice and extracted with methanol. Analysis of triterpenes was performed using Agilent 1200 system equipped with a DAD detector and Kinetex C_{18} column (250 x 4.6mm; 5 µm, with precolumn). The mobile phase consisted of methanol and 0.015M phosphate buffer, pH = 3; (90:10). The flow rate was 0.5 mL/min, the column was kept at 20 ^{o}C and detection wavelength was 214 nm. Peak identity was assessed by comparison of their UV spectra and retention time with respective standard substances. The method has been validated for linearity, precision and accuracy. The OA and UA linearity ranges were 0.04-21.20 mg/100ml of extract (r=0.9992) and 0.08-42.40 mg/100ml of extract (r=0.9992) respectively. The average recovery (n=6) of OA was 93.5% and UA was 109%. This developed method offered the satisfactory LOD of 0.7 and 1.4 mg/100ml and LOQ 2.1 and 4.3 mg/100ml of extract for OA and UA respectively.

In the year 2013 two experiments have been conducted to determine the effect of cultivar and maturity of apples on triterpenes content in apple peel. First was focused on the effect of harvest date and storage on oleanolic and ursolic acid content in apple peel and the second experiment where fruits of seven apple cultivars was used to determine the effect of cultivars on investigated compounds.

Our investigation showed that the content of oleanolic and ursolic acid in dry apple peel depends on the cultivar and maturity of apples and varies from 2 to 5 mg/g for OA and from 12 to 26 mg/g for UA.

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Key words: triterpenes, oleanolic acid, ursolic acid, HPLC, apple peel.

SUITABILITY OF NEW APPLE CULTIVARS FROM HOLOVOUSY FOR LONG TIME STORING IN ULO

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On the basis of 3 years study storage potential of 5 new cultivars in ULO conditions was compared with standard ones - ´Gala´ and ´Golden Delicious´. The uniform ULO parameters corresponding to 2 % O_2, 1 % CO_2 and temperature of 1 °C were applied upon consideration as the best ones upon previous several years study. A range of fruit parameters, soluble solids content and incidence of storage fruit disorders or diseases have been evaluated after 4, 6 and 8 months of the storing. The new cultivar ´Meteor´ selected within progeny of ´Melrose´ and ´Megumi´ had the longest and best storage potential. Its fruits had after 8 months of the storing the same quality as in its picking time and incidence of storage fruit disorders or diseases was never observed. The quite similarly to it was finally evaluated the second novelty named Silvia selected within progeny of ´Glockenapfel´ and ´Šampion´. Its fruits, however, were fewer firms at the end of the storing and slide incidence of fruit shriving or storage diseases was sometimes observed. The other two novelties named ´Resista´ and ´Rucla´ had already shorter storage potential limited up to 6 months in the mean. The worst respond to this ULO storing limited only to 4 moths had ´Angold´ that is otherwise very well stored cultivar.

Key words: apple cultivars, ULO storing, air composition, fruit characteristics, fruit weight losses, storage disorders, storage diseases

AROMA QUALITY OF WILD AND CULTIVATED STRAWBERRIES (*FRAGARIA* SPP.) IN RELATION TO THE FLAVOUR-RELATED GENE EXPRESSION

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Expression profiles of flavour-related genes during ripening and the aroma quality of fruit headspace were investigated in the four strawberry genotypes "Regina delle Valli" (*Fragaria vesca*), "Profumata di Tortona" (*F. moschata*), "Onda" and VR 177 selection (*F. x ananassa*).

Real Time-PCR analysis was used to identify *F. x ananassa* Nerolidol Synthase (FaNES1 e FaNES2) and *F.vesca* Monoterpene Synthase (FvPINS) genes. In *F. x ananassa* genotypes the terpenoid profile was characterized by nerolidol (FaNES1 "VR 177" ΔCt = 14.18), whereas wild species produced mainly monoterpenes (FvPINS "Regina delle Valli" ΔCt = 11.85). The flavour biogenesis in ripening fruit was largely determined by the expression activity of a strawberry alcohol acyltransferase (SAAT) gene, especially in "Profumata di Tortona" (ΔCt = 8.14) and "Regina delle Valli" (ΔCt = 9.80). The *F.x ananassa* O-Methyltransferase (FaOMT) gene activity, which catalyzes the last step in the mesifurane production, was highest in "Onda" (ΔCt = 10.92). The fruit solid-phase microextraction (SPME) headspace was analyzed using the Gaschromatography-Olfactometry (GC-O), that allows the chromatographic separation of volatiles together with their olfactometric evaluation. The aroma quality differed among the genotypes: "Regina delle Valli" had a peculiar profile characterized by high concentrations of limonene (784 µg/100 g fw eq. α-terpineol), linalool (136 µg/100 g fw eq. α-terpineol) and mesifurane (6300 µg/100 g fw eq. α-terpineol) that resulted in "spiced", "citrus, floral" and "sweet, baked" descriptors; the character impact compound in "Profumata di Tortona" was ethyl butanoate, responsible for "sweet" and "fruity, strawberry" descriptors, which, however, was developed in lower amount (69 µg/100 g fw eq. hexyl acetate) if compared to the *F.*x *ananassa* genotypes (VR 177, ethyl butanoate 168 µg/100 g fw eq. hexyl acetate; Onda, 72 µg/100 g fw eq. hexyl acetate). The monoterpene nerolidol was identified in both cultivated strawberry genotypes.

QUALITY POTENTIAL OF SOME NEW PEAR CULTIVARS – HOW TO OBTAIN FRUIT OF THE BEST SENSORY CHARACTERISTICS?

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Eating quality of nine new pear cultivars grown in Poland was investigated during the 2008-2011 seasons. Fruits of two summer cultivars: 'Alfa' and 'Radana', and seven late ones: 'Hortensia', 'Dicolor', 'Concorde', 'Uta', 'Xenia', 'Erika' and 'Verdi' were compared to fruits of 'Clapp's Favorite' and 'Conference' taken as the references. Fruits of all cultivars were harvested from the Experimental Orchard of the Research Institute of Horticulture at the commercial maturity stage and stored at +2.5 °C or -0.5 °C in air (NA) or at -0.5 °C in CA (0.7%CO_2 : 2%O_2) for 6 to 16 weeks. On removal from storage, the fruit of each cultivar were subjected to an individual ripening schedule at 18 °C (up to 14 days) which generated samples of diversified quality attributes. Based on instrumental analyses and descriptive sensory assessment the quality attributes for each cultivar were examined. The gathered data on dynamics of quality attributes changes during ripening stage confirm, that each of new cultivar, needs an individual strategy during storage and ripening to be able to develop their potential market values. The obtained data allow to anticipate that 'Xenia' and 'Concorde' fruits have the biggest chance to fulfil the consumer expectations, as they were clearly higher appreciated than the reference 'Conference' cultivar. Among the others also 'Hortensia', 'Verdi' and 'Dicolor' were higher scored than 'Conference', but their advantages were not so evident.

Key words: pear cultivars, ripening behaviours, firmness, sensory attributes, eating quality

FRUIT QUALITY OF SOME ASIAN PEAR CULTIVARS GROWN IN POLAND

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Asian pears have been grown commercially in Asia for centuries. In Poland they are poorly known and grown on a small scale, but can be an interesting product for Polish consumers as a dessert fruit. Asian pears are juicy, firm and crisp in texture and are good to eat as soon as harvested and after several months of cold storage. In the literature, little information can be found on the quality of fruits of Asian pears grown in Polish climatic conditions.

The aim of this study was to evaluate the fruit quality of 13 Asian pear cultivars grown in Poland. The cultivars tested were: 'Chojuro', 'Dżin Li', 'Er Shi Shinge', 'Er Jang Li', 'Golden 20th', 'Hayatama', 'Hosui', 'Kosui', 'Min Czi Li', 'Nijisseiki', 'San Li', 'Shinseiki', 'Yuan Huang'. Pears were harvested (in 2010 and 2011) at the Research Institute of Horticulture experimental orchard located near Skierniewice. Fruits were stored for 10 weeks at 0 ºC in normal atmosphere conditions. Flesh firmness (FF), total soluble solids (TSS), and titratable acidity (TA) were measured at harvest, after storage and after shelf life (7 days at 18 ºC). After storage and shelf life the sensory evaluation was also performed.

Among the tested cultivars, 'Min Czi Li' and 'San Li' were the most firm (above 45 N) and 'Kosui' the least firm (below 28 N) at harvest time. High amount of total soluble solids (above 11% in both seasons and harvest dates) was noticed for 'Er Jang Li', 'Kosui', 'Chojuro', 'Hayatama', and 'Yuan Huang' pears. Low TSS (no more than 10.6% at harvest) had 'Dżin Li', 'Er Shi Shinge', and 'Nijisseiki' cultivars. The large difference between cultivars was observed in titratable acidity. The highest TA characterized 'Nijisseiki' (above 0.30% in all terms of analyses), and the lowest 'Kosui' and 'Hayatama' (between 0.11–0.13%). In sensory evaluation, among the investigated cultivars, 'Kosui', 'Er Jang Li', 'Yuan Huang', and 'Chojuro' (cultivars characterized by high TSS) obtained high scores for the overall quality (above 5.5 points in 10 points scale). Low scores, no more than 4.5 points, received 'Nijisseiki', and 'San Li' pears.

QUALITY MANAGEMENT OF 'KLUAI KHAI' BANANA IN SUPPLY CHAINS TO MEET THE REQUIREMENT FOR EXPORTING MARKET

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'Kluai Khai' banana (*Musa* 'AA' group) is an important fruit of Thailand for export mainly to China, Hongkong, and partly to Japan. Major production regions are located in the Upper Southern and Eastern Thailand. Due to the stringent investigation of remaining pesticide residues as well as fruit fly and disease contaminations of Japanese plant quarantine, therefore the quality management of 'Kluai Khai' banana has to be started at the upstream supply chain at the farm level through the supply chain operation to the market. Banana production must be managed under Good Agricultural Practice (GAP) certified by the Department of Agriculture, Ministry of Agriculture and Cooperatives, Thailand. GAP-certified orchards were selected to be a partner of banana export companies. Banana bunches must not be treated with any chemical substances before bagging with blue plastic bags. Then, they were harvested when angularity of fruit fingers was at ¾ light full (75-85% maturity). However, the higher maturity had the higher nutritional potential. After harvesting, the growers delivered fruit bunches to the collecting point. Postharvest handling operations were done at the grower's orchard by exporters. Fruit bunches were sorted, dehanded, cleaned, then air-dried and graded according to the quality standard. The fruit hands were then wrapped with individual foam sheets and then packed in a carton box with ethylene absorbers. Fruit hands were packed around 14 kg per box. The boxes were loaded into a refrigerated truck under the controlled temperature at 13-14 °C and transported to the shipment port. Most exporters generally take around 14-24 hours to complete whole operation process. Off-grade fruits were sold to the domestic markets.

Key words: Quality management, supply chains, banana

PROSPECTS FOR MODULATING STORAGE TEMPERATURE AND MOISTURE LOSS IN APPLE AND PEAR STORAGE

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Optimising store temperatures to extend the storage-life of apples and pears requires the identification of tolerance thresholds for varieties over the storage life of the product (4-10 months).A fruits susceptibility to low-temperature breakdown is the product of both temperature and the duration of exposure. Cox's Orange Pippin apples are susceptible to low-temperature injury and require storage at high temperatures (3.5-4.0 °C), however, at these temperatures fruit incur high losses of post-harvest diseases and disorders and are prone to late season softening. While application of 1-MCP aids firmness retention, it can increase the incidence of disease and core-flush development during storage.

Modulation of storage temperatures through the introduction of periods of lower temperature into a standard storage regime may afford the opportunity to maintain fruit quality without inducing low-temperature flesh breakdown. Modulating storage temperature between 1.5-2.0 °C and 3.5-4.0 °C in CA stored (1.2% O_2, and <1.0% CO_2) Cox's Orange Pippin, reduced the incidence of disease development and improve firmness retention. The introduction of a 60 day period of 1.5-2.0 °C followed by raising store temperature (3.5-4 °C) for the remaining 120 days, reduced the rate of softening in 1-MCP-treated Cox and lowered the incidence of rotting associated with *Nectria galligena.* In contrast, fruit kept continually at 1.5-2.0 °C (1.2% O_2, <1%CO_2) for 6 months suffered 30% losses due to low-temperature breakdown, while 1-MCP treated fruit incurred 60% damage.

The potential for lowering storage temperatures for CA stored (5% CO_2, 1% O_2) Bramley Seedling apples from 4.5 °C to 2.5 °C has been observed through enhancing the rate of water loss during storage. Increasing water loss of fruit from 0.9% to 5.4% by the aid of dehumidifiers reduced the incidence of low-temperature breakdown in Bramley's apples stored at 2.5 °C,from 48% to 25 %, respectively, during the initial 150 days of storage, however, after 276 days the incidence of low-temperature damage increased to 86% and 82%, respectively. Additional benefits of enhanced water loss were a reduction in core-flush, senescent breakdown and scald development.

Increasing storage temperatures of Conference pears above the standard - 0.5 to - 1.0 °C (2% O_2, <1% CO_2) may reduce energy costs and moisture loss in fruit and thereby lowering stalk-end shrivel. Pears treated with full or ½ rate 1-MCP and stored at 0.5-1.0 °C maintained acceptable ex-store firmness (60 N) and softened to an eating quality of 15 N within 8 days of shelf-life in contrast untreated pears deteriorated rapidly after removal to shelf-life conditions. However, unless the incidence the post-harvest rots in pears can be controlled, the benefits of higher storage temperatures are limited.

BENEFITS IN APPLE FRUIT FIRMNESS RETENTION AFTER HARVEST ACHIEVED DUE TO SMARTFRESH (1-MCP) TREATMENT OR DYNAMIC CONTROLLED ATMOSPHERE STORAGE BY MEANS OF CHLOROPHYLL FLUORESCENCE (DCA-CF)

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Consumer acceptance of fruits is driven more and more by the internal quality parameters, whereby fruit firmness has evolved to the dominant factor. Former studies with consumers have shown that the eating quality acceptance of apples can be predicted due to instrumental firmness measurements followed by other criteria. Given that the most suitable instrumental measurement of firmness to predict the sensory response of a trained panel to apple texture is the puncture test, the latter has been applied in the present study.
In order to respond best to the different quality challenges along the whole supply chain, distinct measures have to be applied not only in the field, but also in post-harvest and during storage. Assuring an adequate degree of fruit ripeness at harvest is the first effort to limit losses of fruit firmness as long as possible. Further measures have to be implemented during storage, trying to respond best to the ongoing firmness loss, whereby also the impact of the removal date from storage has to be taken into consideration. Limiting firmness loss during storage is primary reached due to the implementation of appropriate cooling procedures and by modifying the storage atmosphere composition with low (CA) or very low oxygen (ULO) concentration and high carbon dioxide content.
In the last decade post-harvest quality of horticultural products was optimized further by the implementation of improved and fine-tuned ULO derived storage technologies such as Dynamic Controlled Atmosphere (DCA) storage by the means of Chlorophyll Fluorescence (CF) sensors (DCA-CF) or by the application of SmartFresh (1-MCP). Especially physiological disorders such as superficial scald could be prevented by both methods, but another advantage could be the improved firmness retention, on which will be placed the focus in the present study. Experimental work was carried out at the Agricultural Research Centre Laimburg (South Tyrol, Italy) over a period of 6 years on fruits among the 6 apple cultivars most commonly grown in Europe ('Braeburn', 'Cripps Pink', 'Fuji', 'Gala', 'Golden Delicious', 'Red Delicious'). The results on fruit firmness retention reached by either DCA-CF storage or SmartFresh (1-MCP) were compared to recommended ULO and/or CA conditions, directly after storage and also after subsequent 7 days in shelf-life, at 20 °C, on three different maturity stages.
The benefits in fruit quality preservation depended to a large extent on the controlled atmosphere storage taken as reference. The 6 years of investigations have shown, that the influence of the storage technologies on better firmness retention differed markedly among genotypes. The best results regarding firmness retention of either DCA-CF storage or SmartFresh (1-MCP) application compared to ULO conditions could be reached on 'Golden Delicious'. Also pronounced increase could be observed on 'Braeburn' and 'Cripps Pink', whereby the firmness increase on 'Gala' and 'Red Delicious' was only slight. Almost no firmness change was observed on 'Fuji'. Generally the positive effect of DCA-CF storage on firmness retention compared to optimal ULO conditions could be observed in all that cases, where SmartFresh (1-MCP) treatment has already evidenced a potential for firmness improvement additionally to ULO. No distinct influence of the fruit's maturity degree on firmness gain reached due to the novel storage technologies could be observed.

THE INFLUENCE OF HARVEST DATE, SMARTFRESH^{SM} (1-MCP) TREATMENT AND STORAGE CONDITIONS ON QUALITY OF 'SHAMPION' APPLES

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In the year 2012, 'Shampion' apples were harvested on 18 and 25 of September (at two ripening stages with internal ethylene concentration 0.05 µl*L^{-1} and 0.13 µl*L^{-1}, respectively) in commercial orchard near Skierniewice. Additionally, at both harvests starch index was assessed and Streif index was calculated. After harvest fruits were divided into two groups. All fruits were cooled down to 1 °C, and on the sixth day, one group was treated with 625 ppb 1-MCP (SmartFresh^{SM}) for 24 hours. Then both, treated and untreated (control) fruits were divided into sub-groups, which were stored for 28 weeks as follows: in Dynamic Controlled Atmosphere (HarvestWatch^{TM}), two controlled atmospheres (0.8% O_2 + 0.8% CO_2 and 2% O_2 + 2% CO_2) and in air (normal atmosphere). After removal from the controlled atmospheres and DCA the fruits were stored for the next eight weeks in normal atmosphere. The following parameters were measured after 1, 8, and 15 days of shelf life (at 18 °C): background skin colour, fruit firmness, total soluble solids content and titratable acidity. At each checking date internal ethylene concentration, ethylene and carbon dioxide production rates were measured for determination of the ripening stage of apples. Sensory analyses were performed by expert panel. After storage the incidence of diseases and disorders was also noticed.
The influence of the examined factors (harvest date, postharvest treatment, storage duration and technology) on ascorbic acid and polyphenols content was also assessed by HPLC method.
Regardless of harvest date and storage conditions the fruits treated with 1-MCP were characterized by higher flesh firmness and titratable acidity than the untreated ones. 1-MCP treated fruits obtained higher acceptance in sensory tests (taste and overall quality) along the extension of shelf life.

Key words: apples, ripening, DCA, CA, ULO, shelf life, sensory analyses

ON SITE MEASUREMENT OF OXYGEN CONCENTRATION IN CHLOROPHYLL FLUORESCENCE BASED DYNAMIC CONTROLLED ATMOSPHERE STORAGE

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The chlorophyll fluorescence (CF) phenomena in fruits and vegetables was adopted in practice in the extremely low oxygen dynamically controlled atmosphere (DCA) storage technology, because of a real time monitoring and control of stored product, accurate determination of lower oxygen limit (LOL), chemicals free control of storage disorders like superficial scald in susceptible apple and pear cultivars, improved retention of quality, possible flavor enhancement and potential detection of senescence, decay or incorrect storage conditions.
Precise measurement of oxygen concentration is important to determine lower O_2 limit in chlorophyll fluorescence based dynamic controlled atmosphere technology storage of fruits and vegetables. Proper detection of a sudden change in fluorescence signal in HarvestWatch™ (Satlantic Inc., Canada) system, correlating to accurately determined oxygen level at its occurrence, helps optimizing the CA storage conditions applied in subsequent period of the long term storage of product. Typical, contemporary electronic flow-through oxygen analyzers have resolution of 0.1% and accuracy of several percent of the measured value, which parameters seem to be a bit insufficient to achieve a high precision measurements of the very low, approaching zero percent, concentrations of oxygen in the storage atmospheres. In the presented study an attempt was undertaken to improve the accuracy of the oxygen level determination by applying on site, direct measurement of O_2 concentration inside the gastight storage chamber. Electrochemical oxygen sensor type KE-25 (Figaro Engineering Inc., Japan) was placed inside the fruit kennel of the HarvestWatch™ system, next to the fluorescence FIRM sensor. The low voltage signal from the sensor was amplified and send to a computer equipped with an analog to digital (AD) converter (12 bit ADDA IBM PC Card). Measurements data were collected periodically and stored on hard disk. Preliminary results of the measurements of the low oxygen concentration in the ongoing 2013/14 storage season are presented along with the data gathered by the computerized, automatic CA control and regulation system Oxystat 2002 (David Bishop Instruments, East Sussex, England) together with the chlorophyll fluorescence F-alpha signal. The new measurement system has a good potential to improve the accuracy of the low oxygen concentration determination, but requires additional refinements and further study.

Key words: chlorophyll fluorescence, oxygen, DCA, measurement, fruit storage

THE EFFECT OF LIGHT SPECTRUM ON THE CONTENT OF PIGMENTS IN *SOLANACEAE* VEGETABLES

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Field and laboratory experiments were carried out during vegetative seasons of 2010, 2011 and 2012 to evaluate the effects of light spectrum on the pigments content in the leaves and fruits of bell peppers and tomatoes. At field conditions the specific light spectrum was provided with plastic films, but at pot experiments with fluorescent lamps. Colorless, red, blue and yellow plastic films were used to cover tunnels in field experiments. White, red, blue and green lamps were used in laboratory experiments. Plants grown under colorless plastic film and white lamps were used as control. Two tomato (*Solanum lycopersicum* L.) and two bell pepper (*Capsicum annuum* L.) cultivars were grown. The content of chlorophyll a and b as well as carotenoides in leaves was determined in ethanol extract. The content of carotenoides in the fruits was determined in the acetone and petroleum ether solution with volume proportion /1:1. The pigment content was detected spectrophotometrically. Significant changes in content of pigments due to modified light spectrum were observed in all experiments. However plastic film usage revealed to have influence on carotenoides content, while colored lamps mainly led to reduction of pigment's content. Tomatoes and bell peppers reacted differently to red and blue plastic film. The yellow film increased carotenoides content in both species.

PEARL SHADE NET IMPROVING QUALITY TRAITS IN PEPPER AFTER HARVEST

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Preharvest treatments are known to influence postharvest fruit quality. Therefore, the goal of this work was to evaluate the influence of Pearl shade net, in comparison to commercial black net, on postharvest fruit quality traits of red pepper (*Capsicum annum* L. cv. Vergasa). Fruits were harvested four times from October to December, and after each harvest they were stored at 7 °C for 16 days and at 20 °C for 3 days. When compared to black netting, Pearl netting significantly reduced water loss, increased fruit firmness and significantly reduced decay incidence after storage, while sugar content (TSS) and titratable acidity were not affected by the net. In addition, ascorbic acid levels and antioxidant activity were significantly increased under the Pearl net. Analysis of correlations among the quality traits indicated that antioxidant activity and ascorbic acid content were closely associated with the other quality parameters, excluding decay incidence. The findings suggest that light manipulation with Pearl netting is more effective in improving postharvest sweet pepper fruit external qualities and increasing nutritional values than with traditional black netting.

ABSTRACTS OF POSTERS

THE YIELDING AND BIOLOGICAL VALUE OF GARLIC CHIVES IN RELATION TO THE TYPE OF MULCHING APPLIED

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Garlic chives (*Allium tuberosum* Rottler ex Spreng) is a little-known in Poland vegetable. Its edible part are primarily aromatic leaves. This perennial plant originates from Asia. Garlic chives is worth our attention due to its high nutritive value and a successful adaptation to the conditions of a the moderate climate.
Multiyear - lasting, one-factorial field experiment was established in the years 2010–2012, in Research – Development Station belonging to Horticulture Department at Wroclaw University of Environmental and Live Sciences. Garlic chives grown in synthetic mulches - black film, black polypropylene textile, in biodegradable film and cut miscanthus straw mulch. In 2013 evaluated the yield and biological value of one –, two- and three–year old garlic chives. On control plots plants were grown without mulches. The size of one plot was 1.44 m^2 (1.2 x 1.2m). The transplants, in the stage of 2–3 fully developed leaves, were group–planted (5 plants per spot) into the field on 15th April, in the spacing 30 x 20 cm. The harvest took place several times within the growing period. During harvest there was evaluated the yield of leaves and shoots with not fully developed inflorescence. In the harvested material there were determined the content of dry matter, reducing sugars, $N\text{-}NO_3$, chlorophyll, carotenoids, P, K, Mg and Ca.
The results of statistical analysis indicated that garlic chives yield did not depend on the type of used mulch. However, in the second year of growing period, the highest total yield (31.29 t ha^{-1}) was obtained from the plots mulched with a black polyethylene film, while the lowest yield - on control plots (24.22 t ha^{-1}). In cultivation involving black coloured mulches, the yield of leaves and inflorescence shoots was, average, by 16.5% higher than that of white film and miscanthus, as well as of the cultivation without mulches. The garlic chives yield statistically depended on the yield of leaves formed by plants in the first year of growing period - higher leaves yield and its higher percentage in total yield provided higher yield in the following year. The leaves of garlic chives contained, among others 9.3-14.2% dry matter, 0.45-2.53% reducing sugars in 100g of fresh matter, 85-229µg carotenoids, 27.1-98.45mg of vitamin C and 25.4-77mg chlorophyll. Chemical compositions of leaves was not affected by the type of mulches.

MODELING PHENOLIC COMPOUNDS DURING STORAGE OF CUT FRUIT AND VEGETABLES: A CONSECUTIVE REACTION MECHANISM

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The changes in the phenolic content of fresh-cut produce during storage are often characterized by an initial growth caused by several abiotic stresses that promote the increase of phenylalanine ammonia-lyase (PAL) activity, which is the first step in phenylpropanoid metabolism. A kinetic model based on a mechanism involving two consecutive reactions was developed to describe the changes in the phenolic content of fresh-cut produce during storage. Experimental data for purslane stored at 0 and 5 °C, apples and broccoli stored at 5 °C, as well as literature data for 'Lisbon' lemon and 'Palazzelli' mandarin samples were used to validate the model, which is consistent with the phenol changes under all of the studied conditions. By estimating model parameters, individually or as group, the storage temperature did not affect the de novo synthesis of phenols but did affect the oxidative degradation for purslane samples. For apples and broccoli samples, biological variability was very important and affected the initial phenolic content and synthesis. Moreover the model also explained the phenolic variation on mandarin segments and on cut lemons. The type of cut for lemon samples had a significant effect on the rate of synthesis of phenols, with an increase of 1.8-fold being observed for the ½ slice compared to the slices. The model may be a useful tool for obtaining a better understanding of the effects of processing and storage conditions on the changes in the phenolic content and improving the shelf life prediction of fresh-cut produce.

MODELING QUALITY CHANGES OF MA PACKAGED ROCKET SALAD UNDER ISOTHERMAL CONDITIONS

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Fresh-cut processing although improve convenience to consumption, increases the rate of degradation reactions as a consequence of wounding to the tissues. In this work degradation kinetics of several quality attributes of packaged fresh-cut rocket stored for 10 days at three temperature (0, 5 and 15 °C) were studied with the aim to predict quality changes under isothermal and non-isothermal conditions. During storage headspace gas composition was monitored. Among sensorial properties appearance score, color, sweetness, bitterness, off-odors, off-flavor, were evaluated using anchored subjective scales. Also firmness, color parameters as well as phenols content, antioxidant capacity and chlorophyll content were monitored during storage. The traditional zero and first order kinetics were compared with the 'Weibullian' power law model with the aim to obtain the best fitting of experimental data. In addition, the evolution of phenols content during time was described with a consecutive first order kinetic model. Furthermore, the quality prediction was obtained by a model which took into account both the temperature dependence and the product thermal history. The majority of the sensorial and physical indexes were best fitted by the non-linear model compared to conventional zero and first order kinetics. Particularly, for appearance score a kinetic order of 1.324 and rate constants of 0.03811, 0.04393 and 0.0849 d^{-1} were estimated respectively for samples stored at 0 °C, 5 °C and 15 °C. When the limit of marketability was considered (score 3), a shelf life of 7.25, 5.83 and 3.79 days and a mass fractions of oxygen of 11.46%, 8.59% and 0.63% were estimated at 0, 5 and 15 °C, respectively. In addition, hypothesizing a fluctuation temperature at 18°C for 24 h (from 1.0 to 2.0 days) a reduction of about 14% of shelf life was calculated.

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PROTOCOL AND TEST REPORT ON SANITIZING WATER TREATMENT ALTERNATIVE TO CHLORINE HYPOCHLORITE

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Today fresh-cut salad companies have to overcome at the same time different challenges in terms of product quality, product safety and cost-effectiveness of the employed technologies. For years sodium hypochlorite has been used as the main technology for sanitizing washing water and products, in particular due to its low cost and effectiveness. However, the increasing awareness of customers on potential risks of chlorine by-products has pushed fresh-cut salad industry to investigate alternative sanitizing treatments. This task becomes more challenging as potential alternatives should have a small impact on industrial cost of products. For these reasons a sodium hypochlorite alternative protocol for water disinfection was defined, tuned and validated. At first attention was focused on the washing water cycle and on the machineries that are usually employed for its processing in a fresh-cut salad plant. Next the washing machines and the parameters that characterize a standard washing protocol were investigated in more detail. This preliminary study is of paramount importance because it is the scenario over which the new protocol for water disinfection was implemented. The protocol is based on results of experimental work. As a first step a preliminary characterization of various water sanitizing agents (sodium hypochlorite, chlorine dioxide, ozone and UV) was performed in order to evaluate their performance and define washing protocols to be tested. From these experiments emerged that ozone and chlorine dioxide are both useful potential candidates to replace sodium hypochlorite. Ozone in particular performed very well in sanitizing water. As for chlorine dioxide a lower reduction of molds and yeasts was observed. Based on experimental evidences four washing protocols were defined, one for every sanitizing agent. In these experiments the main focus was on reduction of the total microbial count on the washed product. From these tests chlorine dioxide resulted the best performing alternative to sodium hypochlorite. In order to overcome the poor performance of chlorine dioxide on molds and yeasts, cold water flow into the washing tanks was subject to a 2-fold increase. The larger cost associated with a higher cold-water flow implies the need to adopt a technology for water reuse. Various available techniques were compared which pursued recovery of water and of thermal energy, including metal mesh filtration, sand volume filtration and ultrafiltration. Results confirmed that ultrafiltration is the best available technology among the examined ones which also contributes to control microbial safety of water.

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THE EFFECT OF APPLICATION OF *TRICHODERMA* FUNGI DURING VEGETATION OF PEPPER AND TOMATO PLANTS ON STORAGE ABILITY OF THE FRUITS

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The effect of different isolates of *Trichoderma* fungi applied during cultivation on storage ability of pepper and tomato was studied in 2013.

Pepper

Plants of sweet pepper cultivar Olvera F_1 were grown in unheated tunnel. Two methods of *Trichoderma* application were used: (1) soil amendment of fungal biomass on organic carrier two weeks before planting of pepper transplants or (2) spraying of the plants with conidial suspensions. One of the treatment was spraying with fungicide Amistar. Pepper was stored for 3 weeks at 8^{o}C in the crates lined with PE film. Quality of the fruits during storage was evaluated at 7 days intervals. Market value, degree of fruit wilting and infestation by diseases were assessed with the use of 1 – 9 index.

Fruits maintained good firmness during whole period of storage. The first evidences of rotting were found after 7 days of storage in treatments: control, control+organic carrier, organic carrier+isolate A2 of *Trichoderma*, organic carrier+isolate A3 of *Trichoderma* and in the treatments where plants were sprayed with conidial suspensions of isolates A2+A1. All fruits in other treatments were healthy. After 2 weeks of storage the fruits from all treatments were partially rotten, but still 75-86% of fruits were healthy. The highest market value after 3 weeks was found for pepper in the treatment where isolate A3 was applied to the soil on organic carrier. Almost 64% of fruits in this treatment were healthy. The lowest market value and the lowest percent of healthy fruits were noted for treatment A2+A1(s) (spraying with conidial suspensions of isolates A2+A1 of *Trichoderma*).

Tomato

Tomato plants (greenhouse variety Growdena F_1) were cultivated in greenhouse, in prolonged cycle on rockwool slabs Grodan-Grotop. Tested *Trichoderma* strains were applied to rockwool slabs as spore suspensions six times at monthly intervals during the growing season after transplantation of tomato seedlings. Also Trianum was applied as commercial control. Tomato fruits were stored for 2 weeks at 12^{o}C in the crates lined with PE film. Quality of tomato during storage was evaluated every 2 days as it was described for pepper.

Tomato fruits were of excellent quality during first 4 days of storage. In next 2 days the signs of rotting have appeared on fruits of all treatments. After 14 days only 22-25% of fruits were healthy, excluding the object where tomato were treated with commercial product Trianum. Only 3% of fruits were healthy in this treatment.

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THE EFFECT OF CONTROL ATMOSPHERE AND ETHYLENE ON QUALITY AND CONTENT OF SOME COMPONENTS OF ONION BULBS

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The experiment was carried out in the years 2011/2012. Onion of two cultivars: Grabowska and Kristine was stored in controlled atmosphere (CA) containing 2% CO_2 - 2% O_2, 2% CO_2 - 2% O_2 + 15 ppm ethylene, 3% CO_2 - 5% O_2, 3% CO_2 - 5% O_2 + 15 ppm ethylene. Onion was stored also in atmospheric air and in atmospheric air + 15 ppm ethylene. The storage temperature was 3 ^{o}C and storage period 6 months. The weight losses, percent of bulbs which meet the requirements of export onion (hard and not sprouted, not rooted, with at least one good adhesive dry husk), bulbs with roots, sprouted bulbs and spoiled bulbs were determined after storage period. Chemical analyses of onion for content of dry matter, total sugars, vitamin C and soluble polyphenols were performed.
The higher percent of export onion was found after storage in controlled atmosphere compared to normal atmosphere. Addition of ethylene to controlled atmosphere and normal atmosphere influenced on increase of percent of export onion after storage.
Among tested CA composition the best results were found for onion stored in atmosphere containing 2% CO_2 - 2% O_2 + 15 ppm ethylene. The decrease of quality of onion stored in CA was due to cracking of dry onion husk. Onion stored in normal atmosphere was characterized with crackings on dry onion husk, onion sprouting and onion rooting. The higher percent of export onion after storage was found for cv. Krystine from controlled atmosphere and from normal atmosphere.
Fresh onion of cv. Krystine was characterized with higher content of dry matter, total sugars and polyphenols compared to cv. Grabowska. Decrease of total sugars content after 6 months of storage was found in onion of all treatments. Increase of vitamin C content in onion after storage was observed. The highest level of vitamin C content was noted in onion cv. Grabowska after storage in normal atmosphere with addition of ethylene but in onion cv. Kristine in atmosphere containing 2% CO_2 - 2% O_2. Also in onion of cv. Grabowska the polyphenols content has increased after storage period.

STORAGE ABILITY OF SELECTED SCALLOP SQUASH CULTIVARS GROWN FOR FRUIT PROCESSING

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Actually in the Polish Register List there are included 5 cultivars of scallop squash diversified in terms of the shape and color of fruits. In the last years there is observed a growing interest to use this vegetable species for processing, mainly for canning, freezing and as a component of ready to use vegetable salads. The most suitable for this purpose are small unmatured fruits with high nutritional value and thin, delicate skin.

The aim of the present study was to determine the storage ability of the available on the market cultivars of scallop squash (Disco, Okra, Gagat, Polo F1. Sunny Delight F1) harvested at the stage of 3-6 cm fruit diameter. Samples of fruits collected in the time of maximum fruiting period were placed in the storage room in the temperature of 7ºC and relative air humidity > 95% for the period of 7, 14 or 21 days. In each term the quantity of weight loss and changes of chemical fruit composition were evaluated.

The mean weight losses for all tested cultivars after one week period of cold storage equalled 4.92%, and drastically increased in the subsequent term of investigation. These data as well as diminished external appearance indicate that only the storage not longer than for the period up to 7 days can assure the quality of small size fruits which meet the demand of fresh market and industrial processing. The least weight losses characterized 'Okra' (1.07 %) and 'Disco' (1.32 %), while the highest 'Gagat' (11.50 %) followed by 'Sunny Delight F1' (6.18 %).

Sunny Delight F1 cultivar, highly appreciated for its yellow color skin of fruits contained the highest amounts of dry matter, while Disco – vitamin C and polyphenols. Irrespective of kind of cultivar, prolonged period of cold storage was associated with the drop of dry matter, vitamin C, carotenoids and nitrates content, with the enhancement of polyphenols in scallop squash fruits.

NEW APPROACHES FOR NON-DESTRUCTIVE EVALUATION OF FRUIT RIPENING WITH OPTICAL METHODS AND MULTIVARIATE DATA ANALYSIS

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For effective production of high quality fruit, exact knowledge of ripening dependent variation in value adding ingredients and overall fruit quality is very important. Conventional methods provide only restricted means to continuously and objectively analyse entire fruit during ripening and in postharvest. Based on results of on-tree monitoring of overall quality during growth with spectroscopic and imaging techniques, advanced chemometric data analysis was applied to develop predictive models that allow for a rapid, non-invasive evaluation of ripening and quality of single fruit.

During the growing seasons 2008 to 2013, five plum (*Prunus domestica* L.) cultivars (early, medium and late) were studied to analyse changes in fruit quality parameters (size, colour, elasticity) and ingredient contents (sugars, acids, pigments) during ripening. At the same time, intact plums were non-destructively evaluated by remission and reflectance spectroscopy and chlorophyll fluorescence imaging.

Besides the information such as pigment contents, spectra contain additional details, which contribute to a variation of spectral data. This variance does not only result from fruit ingredient but is also a consequence of inhomogeneous sample material, light scattering and/or inaccuracies of measuring devices. Application of optimized techniques of chemometric analyses (e.g. PCA, PLS, iMLR) facilitates the simultaneous inclusion of several interacting variables into data evaluation and, thus, extraction of certain fruit features from the entire set of spectral information. For optimization of mathematical models for prediction of these specific fruit features, various data pre-processing methods were tested. For validation of models, all data were analysed in dependents of respective seasons.

EFFICIENCY OF THE ADDITIONAL FERTILIZATION WITH DIFFERENT NITROGEN FERTILIZERS AND RATES IN GROWING OF RED BEET OF EXCEPTIONAL QUALITY

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While growing the production of exceptional quality, special requirements are being made – the amount of nitrogen scattered during vegetation is limited.
The aim of investigations – instilling new progressive technology of the growing of root-crop vegetables of exceptional quality to choose for the additional fertilization the most suitable nitrogen fertilizer and its rate in order the soil, environment was polluted as little as possible and the qualitative production was obtained.
There were grown red beet 'Boro' $F_1$and 'Bonel'('Detroit' type, averagely early). There was investigated the influence of nitrogen fertilizer used for additional fertilization (ammonium nitrate and calcium nitrate) and their rates ($N_{30}$and N_{15}) on red beet yield, its quality and storability. Additional fertilizations were carried out at 2–4 red beet leaves stage. Red beet were grown on flat surface, sowing scheme 62+8, there were sown 500 thousand unt. ha^{-1}germinable seeds. Before sowing the field was fertilized with complex fertilizers, scattering N_{84}. Red beet during vegetation period were additionally fertilized through leaves for three times applying soluble complex fertilizers.
Experiments were carried out in calcaricepihypogleyicluvisol of sandy loam on light loam soil (IDg8-k), *Calc(ar)i-Epihypogleyic Luvisol* (*LVg-p-w-cc*).
Data of investigations showed that red beet hybrid was more productive than cultivar (marketable yield 64.2 and 53.7 t ha^{-1}). Calcium nitrate was more effective both to hybrid and cultivar. Vegetables fertilized with it was preserved better than these fertilized with ammonium nitrate. The average amount of nitrates after application of nitrogen fertilizer was on the average 866.0 mg kg^{-1}; while growing without additional fertilization – 907.2 mg kg^{-1}.

VALIDATION OF INNOVATIVE METHODS FOR HUMAN PATHOGEN BACTERIA DETECTION IN FRESH CUT VEGETABLES

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In the framework of the QUAFETY FP7 – EU project innovative diagnostic methods have been developed for the detection and quantification of *Listeria monocytogenes* and *Escherichia coli* O157:H7 in minimally processed fresh cut fruits and vegetables. The aim of the present study was to validate the technical efficiency of these methods and evaluate their efficacy and viability for routine analysis. For this purpose, ready-to-eat fresh fruits and vegetables, have been collected throughout the production chain. More accurately, a total of 48 samples of rocket, mixed salad and *piel de sapo* melon have been provided by Italian, Portuguese and Greek SMEs. A multidisciplinary approach, including newly developed ELISA and MPN-qPCR methods as well as ISO procedures have been used to detect the pathogenic bacteria after harvesting, processing, packaging and shelf-life.

Results obtained exhibited the technical efficiency of the developed methods. More accurately, both methods had similar sensitivity, specificity, negative predictive values and negative likelihood ratios. False positive results obtained by the ELISA method resulted in the reduction of positive predictive values. Regarding their efficacy and viability for routine analysis it is mostly dependent upon available equipment and technical expertise.

BIOLOGICALLY ACTIVE SUBSTANCES IN FRUITS OF EUROPEAN CRANBERRY BUSH AND THEIR STORABILITY

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The species *V. opulus* L. has a history of use in food, pharmaceuticals, and medicine. The fruits have been used to treat a wide range of maladies including heart disease, coughs and colds, digestive troubles, and bleeding. These investigations were focused on biochemical components and storage of *V. opulus* fruits. The investigations of the biochemical composition of fruits of different cultivars revealed significant differences in the amounts of total phenolics (anthocyanins and flavonols). The Russian cultivar 'Leningradskaya Otbornaya' was distinguished by the largest amount of anthocyanins. Fruit of the cultivar 'Krasnaya Grozd" and the clone P2 accumulated the largest amounts of benzoic acid. Analyzed *V. opulus* genotypes are good sources of valuable biologically active substances possessing antioxidant activities. Loss of fruit mass was from 0.75% *(V. opulus* var*. sargentii*) to 1.07% (*V. opulus* var*. trilobum*) after the first 7 days of storage. The minimal mass loss of fruits after 42 days was determined for *V. opulus* var*. sargentii*.

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HEALTH PROPERTIES OF GARLIC (*ALLIUM SATIVUM* L.) OF POLISH AND FOREIGN ORIGIN

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Garlic is widely used for different purposes due to its taste and high health properties, determined by several factors, among others origin, cultivation and storage time. According to the preferences for garlic cultivated in Poland, its health properties were verified and compared with those of garlic cultivated in China, Spain and Argentina. All of used garlic belong to the winter type building the flowering stalk.
The laboratory experiments were performed in 3 series in June and July in 2 weeks intervals with four repetition per combination within one series. Investigations comprised analyses in conformity with the Polish Agricultural Standards PN-R-75518:1996, in addition to determinations of the content of total polyphenolics, ascorbic acid, and antioxidant capacity measured as FRAP. All analyzed objects gained the minimum requirements for quality and grading. However, some disagreements were found, related to the declared diameter of bulb, the lack of full information about the product on the label, the lack of uniformity within the package unit, and the presence of spoiled garlic cloves after peel removal. Conducted determinations showed the highest content of total polyphenolics calculated as GAE in the Chinese garlic – 2255.00 mg kg^{-1} f.m., followed by Argentinean garlic –1519.10 mg kg^{-1} f.m., Spanish garlic – 1304.67 mg kg^{-1} f.m., Polish garlic – 1052.90 mg kg^{-1} f.m., and the Polish young garlic – 360.87 mg kg^{-1} f.m. Furthermore, garlic of Chinese origin was characterized by the highest antioxidant capacity of 39.31 mmol kg^{-1} f.m., followed by Argentinean garlic 33.87 mmol kg^{-1} f.m., Spanish 22.04 mmol kg^{-1} f.m., Polish garlic 19.88 mmol kg^{-1} f.m., and the least capacity was found in Polish young garlic – only 8.58 mmol kg^{-1} f.m. However, the highest ascorbic acid content was found in Polish garlic 7.73 mg kg^{-1} f.m., followed by young Polish, and Argentinean garlic 4.83 mg kg^{-1} f.m., Spanish garlic 3.87 mg kg^{-1} f.m., and Chinese garlic 2.9 mg kg^{-1} f.m. Considering all investigated parameters, the Chinese garlic was characterized by the highest health promoting properties and, due to its value, should be recommended for consumption.

ANTIOXIDATIVE ACTIVITY *IN VITRO* OF DIFFERENT *VACCINIUM* GENOTYPES

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In recent years increased attention has been paid to horticultural plants which fruits are source of biologically active substances known for their antioxidative properties. To increase the use of blueberry fruit in pharmaceutics, a better understanding of their biochemical components and health-promoting activities is needed.

Antioxidative properties of berry juices of 19 blueberry genotypes (*Vaccinium corymbosum* L.) as well as wild genotype of bog blueberry (*Vaccinium uliginosum* L.) were evaluated by $ABTS^{\cdot+}$ radical scavenging capacity (RSC), ferric reducing antioxidant power (FRAP), and oxygen radical absorbance capacity (ORAC).

$ABTS^{\bullet+}$ antioxidant activity was varying from 6.48 µmol TE/g to 20.90 µmol TE/g. The highest antioxidant activity in this assay was determined for bog blueberry (20.90 µmol TE/g), the Lithuanian cultivars 'Freda' (12.0 µmol TE/g) and 'Danutė' (11.5 µmol TE/g). The reducing power in FRAP assay may be expressed in Fe^{2+} equivalents and/or Trolox equivalents. Antioxidative activity in analyzed *Vaccinium* was varying from 4.9 Fe^{2+}/g and 3.0 µmol TE/g to 31.9 µmol Fe^{2+}/g and 17.8 µmol TE/g. The highest FRAP values were obtained for bog blueberry juices (31.9 µmol Fe^{2+}/g and 17.8 µmol TE/g). The range of ORAC assay among the different *Vaccinium* berry genotype was varying from 4.2 µmol TE /g to 45.6 µmol TE/g. The highest values of all the analyzed berry samples were determined for bog blueberry (45.6 µmol TE/g), the Lithuanian cultivar 'Danutė' (20.7 µmol TE/g) and the cultivar 'Northland' (20.1 µmol TE/g). The juices of newly bred Lihuanian cultivars and bog blueberry demonstrated significantly stronger antioxidative properties.

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THE INFLUENCE OF DRY MATTER AND REDUCING SUGAR CONTENT IN THE ANNUAL SHOOTS ON THE FLOWERING INTENSITY OF PLUMS

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The most tender parts of stone fruits during wintering period are flower buds. Therefore it becomes more significant to increase winter hardiness of plum flower buds to ensure stable and high yields. Freezing of flower buds is mentioned as one of the most significant winter damages for stone fruits. One of the significant factors ensuring winter hardiness is compatibility of rootstock and graft. The lack of appropriate plum rootstocks in Latvia and Estonia caused the necessity to investigate several rootstocks ensuring high quality yields. The aim of the investigation was to compare the changes of the content of reducing sugars and dry matter in the annual shoots during wintering period and their influence on the trees wintering ability.

The dynamics of reducing sugars was investigated during two winter seasons (2011/2012 and 2012/2013) in one-year-old shoots of hybrid plum 'Kubanskaya Kometa' (*Prunus rossica*. Erem.) from two orchards planted in 2001 at Pūre Horticultural Research Centre (Latvia) and Polli Horticultural Research Centre (Estonia). Cultivar 'Kubanskaya Kometa' was grafted on eight clonal rootstocks: 'St. Julien A', 'Brompton', 'Ackermann', 'Pixy', GF8/1, G5/22, GF655/2, 'Hamyra' and eight seedling rootstocks: 'St. Julien INRA 2', 'St. Julien d'Orleans', 'St. Julien Noir', 'Brompton', 'Wangenheims Zwetche', 'St. Julien Wädenswil', 'Myrobalan' and *Prunus cerasifera* var. *divaricata.* Trees were planted at 5x3 m spacing in four replications per rootstock with three trees per plot. Shoot samples were harvested two times during the wintering period – in the middle of December and in the end of March. Dry matter content (mg g^{-1}) was detected in laboratory. The concentration of reducing sugars (mg g^{-1} DW) was determined by Bertran's method. The tree flowering intensity was quantified using the scale from 1 to 5, where 1= no flowers, 5= abundant flowering. Analysis of fluctuations of reducing sugars and dry matter as well as flowering intensity shows influence of meteorological conditions on the evaluated parameters.

THE INFLUENCE OF HOT WATER TREATMENT ON STRUCTURE OF ROCKET LEAVES TISSUES

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The aim of the study was microscopic assessment of rocket leaves structure after hot water treatment and short-term storage in various temperature conditions.The study was carried out on rocket salad (*Eruca sativa* M.) cv. 'Siewna'. The plants were cultivated on Experimental Field of Research Institute of Horticulture. Immediately after harvest the leaves were sorted and trimmed. Next the leaves were treated in hot water by dipping in water bath with temperature ranging from 38 to 57 °C and time duration from 20 min. to 3 s. After treatment the cut vegetables were dried, cooled to equal temperature, packed into polystyrene foam trays and put in cold chamber at 0-1 °C, 5 °C and 18-20 °C. The effect of hot water treatment on rocket leaves was examined using stereoscopic microscope Olympus SZX16 with Cell program (for photographic documentation), light microscope Nicon Eclipse 80i with program NIS-Elements BR 2.30 and scanning electron microscope JEOL JSM-6390LV in Mossakowski Medical Research Centre Polish Academy of Sciences in Warsaw. Anatomical preparations were made using paraffin method after fixed fragments of leaves in CrAF (chromic acid, acetic acid, formalin), dehydrated in ethanol and prepared for light microscope and scanning electron microscope analysis. First part of prepared fragments was next embeded in paraffin, cut and stained with safranine and fast green for light microscope investigation. Next part of leaves fragments were desiccated with Critical Point Drying CO_2 and sputter - coated with gold and then examined with the scanning electron microscope. The stomata in very large numbers are present as in the upper as in lower epidermis of leaf. The fresh leaves were dominated by open stomata, and after treatment with hot water most of the stomata were closed. The cells of parenchyma of fresh leaf presented loose structure with large intercellular spaces. The damaged leaf tissue caused by foraging pests was often observed in analyzed material. Under treatment with hot water followed limitation of yellowing leaves around the tissue damage caused by pests for aging, was observed in the material stored. Too high temperature (55 ^{o}C) caused the separation of palisade parenchyma from the layer of spongy parenchyma in some leaves of rocket. Microscopic analysis showed that the best preserved structure of the rocket leaves was treated with hot water at 53 °C and stored in temp. 1 °C.

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EFFECT OF ROOTSTOCKS AND STORAGE CONDITIONS ON SWEET CHERRY FRUITS QUALITY

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The studies were investigated in years 2009-2012. The effect of several rootstocks (F12/1, Colt, GiSelA 5 and P-HL A) and differentiated storage conditions (controlled atmosphere containing 5% CO_2 and 3% O_2 and normal atmosphere) on the chosen quality traits of sweet cherry cv. Regina was investigated. Fruits were collected from the orchard planted in 2002 year, in Experimental Station of Pomology and Apiculture Department, in Garlica Murowana, near Kraków. Sweet cherry fruits were stored for 14 days.
The following fruit quality traits were investigated: firmness [N], soluble solids content [%], titratable acidity [%] and the occurrence of storage–related diseases.
The obtained results revealed that both the rootstock and the storage conditions significantly affected the studied fruit traits. The effect of rootstock on sweet cherry quality revealed in different way depending on the investigated parameters. Generally, controlled atmosphere (CA) conditions better maintained the higher fruit quality as compared to normal atmosphere conditions (NA).

THE INFLUENCE OF 1-MCP AND CA STORAGE ON SOME PHYSICAL TRAITS OF 'CHERRY' TOMATOES

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1-MCP (1-methylcyclopropene), the ethylene receptors blocker, is commonly used in horticultural practice for delaying ripening, mainly for apples. Controlled atmosphere (CA) is also the method which can be used for prolonging storage period of many horticultural crops, including tomatoes. Tomatoes of 'cherry' type become very popular on the European market, but there are few research data on postharvest methods for this crop. The objective of this study was to determine the effect of 1-MCP treatment and the effect of storage under CA conditions on some physical quality traits of 'cherry' tomatoes (*Solanum lycopersicum* L. var. *cerasiforme*). Cultivars used in the study were 'Dasher F1' and 'Pareso F1'. In the 2-year experiment, the plants were grown in a greenhouse and fruits for the experiment were harvested at pink fruit and light-red fruit stages of maturity (3rd and 5th stage, according to USDA classification). 1-MCP was applied after harvest on fruits at the two stages of maturity in concentration of 1 ppm, for 12 hours at 18 ^{o}C. In paralel, 1-MCP untreated fruits which were harvested at pink fruit stage of maturity were stored under different gas compositions: 3% CO_2 + 3% O_2, 3% CO_2 + 1.5% O_2 and under normal atmosphere. The fruits were stored for up to 4 weeks at 12 ^{o}C, than moved to 20 ^{o}C to obtain consumption maturity. Physical traits determined before and after storage period (2, 3 and 4-week storage) were: colour in CIE L*a*b* system (with HunterLab spectrophotometer), where L* – lightness, a* – red colour intensity and b* – yellow colour intensity were determined, as well as fruit firmness (with HPE apparatus, Bareiss, Germany). Also c* (chroma value), a*/b* index and H^{o} (hue angle) were calculated. The results showed that 1-MCP treatment significantly reduced decreasing of fruits firmness during storage, as well as changes of their colour parameters. The effectiveness of CA in both gas compositions was no so high. Especially, the CA storage did not affected firmness degradation to the same extent as the 1-MCP treatment. It can be concluded that 1-MCP treatment is an effective method in delaying ripening of the 'cherry' tomato fruits by better keeping their firmness and colour and could be applied, from this point of view, to prolong their 'shelf life'.

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POSTHARVEST TREATMENT EFFECT ON STORAGE ABILITY OF APPLES

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'Šampion' apples on the day of harvest were immersed in water solutions of several commercial products: HUWA-SAN (0.05%), paraffin oil (0.05%) and PROTECTOR (1.0%). Separate lots were subjected to a hot water bath (50°C) and to a standard treatment with SmartFresh™. Treated apples as well as non treated control ones were stored in a normal atmosphere storage rooms at 3 °C. Fruits after storage were analyzed after two durations – first after 3 months and the second after 4 months. Experimental samples were divided for two lots, one for direct after storage assessments and the second after additional seven days shelf life period in room temperature. Fruit weight loss, flesh firmness, total soluble solids (TSS) content, pH, titratable acidity (TA) and TSS to TA ratio were assessed. The incidences of physiological disorders and storage diseases were also evaluated.

INFLUENCE OF STORAGE TEMPERATURES ON QUALITY PARAMETERS ON FOUR ASIAN PEARS CULTIVARS

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Objective of this study was to investigate the influence of post-harvest storage on the physicochemical parameters (soluble solids, titratable acids, flesh firmness, antioxidative capacity, color parameters) of the Asian pear fruit cultivars 'Hosui', 'Chojuro', 'KumtGhan Chu', 'Pung Su'. Cultivars were stored at temperatures 4 °C, 18 °C, 24 °C in a normal oxygen atmosphere. Sample intervals for analysis depended on a rate of softening of flesh in particular storage temperatures.
Firmness of the flesh for all cultivars decreased mainly in the first 10 days of storage at 4 °C and changed very little during the next 30 days even after removal from cold storage temperature in terms of shelf life. Conversely, there was a significant/substantial softening of fruit flesh during storage of fruits at 18 °C during 20 days. For example, in the firmest fruit cultivar 'Chojuro' changed the initial flesh firmness (1.34 MPa) to a value of 0.24 MPa after 40 days of storage at 18 °C. The highest value of antioxidant capacity was measured in cultivar 'KumtGhant Chu' using both methods 0.396 $mmol \cdot l^{-1}$ (FRAP) and 0.367 $mmol \cdot l^{-1}$ (DPPH). The value of antioxidant capacity decreased significantly during storage in fruits stored at higher temperatures. There wasn't observed a clear trend for soluble solids content during storage of fruits.

UV-C TREATMENT CONTROLS MICROBIAL POPULATION ON FRESH-CUT MELONS WITHOUT NEGATIVE EFFECT ON THEIR QUALITY

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Netted melon rind harbors numerous microorganisms attached to its surface. Washing melons with sanitizing solutions reduces the microbial population but cannot completely eradicate it. Cutting inadvertently transfers the microorganisms from the produce surface onto the wound area providing a favorable milieu for microbial growth, including causative agents of product spoilage and of human diseases. No liquid decontamination means are normally applied to delicate fresh-cut fruit pieces. Therefore, measures for "dry" decontamination are required to ensure microbiological quality and safety of fresh-cut fruit e.g. melons. In this work we tested the efficacy of short-wave ultraviolet light (UV-C) for controlling microbial proliferation on the cut surface of melon flesh. The work was conducted with Ananas-type melons (*cantalupensis* group). The fruit were surface decontaminated with NaClO solution and transversally cut into 3-cm thick discs. The discs were exposed from both cut sides to UV-C for 1 to 10 minutes, or not exposed at all (control). Melon flesh plugs were excised from the discs with a sharp cylindrical cutting instrument and stored in plastic containers at 6-8 °C for 5-6 days. The microbial load on the cut melon plugs was checked at the beginning and at the end of the storage. Just minor reduction of viable microbial counts was observed on the cut melon surface immediately after the UV-C exposure. However, the UV treatment significantly affected or in some cases even stopped further proliferation of the microbial populations on the treated cut melon surfaces, so that at the end of storage the microbial counts on the UV-treated samples were 2-4 log CFU/g lower than in the control. The best results were achieved with exposure durations of 3 to 5 minutes (doses 0.9 to 1.5 kJ/m^2). Similar trends were observed in the trials involving cut melons artificially inoculated with a spoilage bacterium *Pseudomonas putida*. The results of the work imply that UV-C affects cell division of the bacteria and in addition might induce antimicrobial defense responses in melon tissues. No negative effects on the fresh-cut melon quality were observed at optimal UV-C doses.

EFFECTS OF VEGETATIVE PERIOD ON QUALITY OF JERUSALEM ARTICHOKE TUBERS

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The aim of this research was to determine the chemical composition in the different parts of Jerusalem artichoke (*Helianthus tuberosus* L.) tubers during their vegetative period.
During the year of 2011–2012 in organic farm in South of Lithuania the following Jerusalem artichoke cultivars were grown for the investigations: 'Sauliai', 'Albik', 'Rubik'. Samples were taken eight times per two periods during tuber vegetation: March-July and August-December. Tubers were cut in cross direction in to three parts – the upper, middle and lower. Amounts of dry matter, soluble dry matter, vitamin C, potassium, and nitrate in each part of tuber were determined using a standard methods. The data were statistically treated using Anova data analysis and management module of the integrated system STATISTICA. Averages of separate treatments were calculated, the standard deviation and the least significant difference at a 95% probability level were estimated using the Fisher's LSD test ($P<0.05$).
The significant highest amount of dry matter were determined in the upper tuber part of 'Sauliai' in the end of March, as well in the middle and in the lower tuber parts of 'Albik' – in the end of October and in the end of April, October, November respectively. The highest content of soluble dry matter in the upper tubers part of 'Sauliai', 'Albik' and 'Rubik' were determined in the end of October. The most reliably vitamin C amount was accumulated in the upper tuber part of 'Sauliai' in the end of May, in the middle tuber part of 'Rubik' – in the end of March and in the lower part of tubers of 'Albik' – in the end of May. Reliably highest amounts of potassium were accumulated in the end of March in the middle part tubers of cv 'Sauliai', as well in the upper and middle parts of the tubers of cvs 'Albik' and 'Rubik' – respectively. Significant lowest nitrate amounts were determined in the end of March in all parts of 'Sauliai', 'Albik' and 'Rubik' cv. tubers.

Key words: Jerusalem artichoke, tubers, vegetative period, quality.

THE INFLUENCE OF NANOGRO® ORGANIC STIMULATOR ON YIELDING AND FRUIT QUALITY OF FIELD CROP TOMATO

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Yielding of field crop tomato cultivated in polish climatic conditions depends on many factors. Obtaining high yield, of good fruit quality appears to be depended on ability and possibility of tomato plants preventing stress factors. Frequently the plant defense reaction occurs too late and losses result in low and bed quality yield. Therefore searching for new solutions aimed at inducting a natural defense mechanism of the plant (SAR) is necessary.
Nano-Gro® is an organic stimulator of the growth and development of plants, containing in its composition oligosaccharides with addition of the sulfates of the elements Fe, Co, Al, Mg, Mn, Ni, Ag in nanomolar concentrations (10^{-9}).
The aim of the study was to determine the effect of different methods of stimulator Nano-Gro® application on tomato plant growth and yield and its quality. In the experiment four treatments were used: NanoGro® application on seeds, application on plants, application on seeds and plants and control without NanoGro®. In the study determinate tomato cultivar 'Mieszko F_1' was used.
A significant influence of NanoGro® application method on tomato plant growth, yield and its quality was stated. Pre-sowing application on seeds positively influenced on plant height and thickness of the stems. The highest total and marketable yield was observed in plants which seeds were treated with NanoGro® (respectively 87.02 and 53.13 t·ha^{-1}) and in those were it was used seed treatment combined with spraying plants (respectively 73.48 and 45.67 t·ha^{-1}). The lowest marketable yield was stated in the plants from control objects (37.91 t·ha^{-1}).
The various methods of Nano-Gro® stimulator application had a positive impact on the chemical composition of tomato fruit in comparison with control. Nano-Gro® seed treatment combined with plant spraying resulted in an increase of dry matter, sugars and vitamin C content, whereas using only plant spraying increased the lycopene and β-carotene content in fruits.

1-METHYLCYCLOPROPENE (1-MCP) INFLUENCE ON APPLE QUALITY DURING STORAGE TIME

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The ethylene perception inhibitor 1-methylcyclopropene (1–MCP) is the basis of a new technology that is increasingly being used to improve storage potential and maintain quality of fruit and vegetables. Since 2004 1-methyciclopropene (1-MCP) is widely used on apples around the world. 1–MCP has a gas state of aggregation, which replace the ethylene (C_2H_4) molecules, not allowing it to attach to the ethylene receptors. As a result inhibition of ethylene action on the fruits occurred. Ethylene is a gaseous plant hormone that accelerates the ripening of climacteric fruit including apple. 1-MCP delays the ripening and senescence of fruits significantly. The maximum duration of storage time of fruits as well as quality can be achieved by precisely observation of the optimal harvesting time for each cultivar independently. Latvia State Institute of Fruit-Growing accomplished the investigation on storage time with the most cultivated apple cultivars by treatment with 1–MCP in various stages of maturity. The aim of this research was to develop the recommendations for the use of innovative technologies in commercial area in Latvia. The investigation was carried out in 3 years where 6 apple cultivars were studied. The physical – chemical parameters: firmness, acidity, sweetness, rate of hydrolysis of starch at the time of harvesting and during storage were tested. The sensory evaluation of samples was also conducted. During the apple storage in repository the fruit spoilage reasons and the fruit mass losses were identified. The optimal maturity index for most of apple cultivars ranged from 0.11 to 0.23. As found by experts, treated fruits with 1–MCP after 6 months of storage has more appropriate succulence, are crisper and sweeter compared to the non-treated fruits.

EVALUATION OF YIELD AND MORPHOLOGICAL PARAMETERS OF EDIBLE ONION (*ALLIUM CEPA* L.) GROWN IN LITHUANIA

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The study was carried out in the experimental field of the Institute of Horticulture Lithuanian Research Centre for Agriculture and Foresty (IH-LRCAF) in 2008 – 2010. Investigations for yield and morphological parameters of the most popular edible onion (*Allium cepa* L.) cultivars grown in Lithuania were carried out. Three onion varieties - *Babtu didieji*, *Red Baron*, Nr.080 and ten hybrids – *Spirit* F_1, *Burgos* F_1, *Mission* F_1, *Napaleon* F_1, *Vision* F_1, *Solution* F_1, *Sunskin* F_1, *Musica* F_1, *Stamford* F_1, *Red Beauty* F_1 were analyzed.
The yield and its structure was calculated. The height and diameter of onion bulbs were estimated. Statistical analyses of results were processed by using the ANOVA method according to Fisher's and Duncan's multiple range for mean separation at 5% level and analysis of principle coordinates.
Obtained rezults showed that our climatic and soil conditions are favourable for onion growing. The metheorological conditions in the year 2008 and 2009 were more optimal for onions growth and yield formation in comparison with 2010. All investigated cultivars were differed according possibility of yield formation. During period of three years investigation onion of hybrid *Musica* F_1, distinguished with the highest total and marketable yield. The highest output of marketable yield was determined from the hybrid *Vision* F_1. The highest size of bulb was obtained from hybrid *Stamford* F_1 .That proves that cultivar is an important factor that affects crop productivity.

Key words: cultivar, edible onion, morphological traits, yield

EFFECT OF EDIBLE COATING ON POSTHARVEST QUALITY OF PLUM (*PRUNUS DOMESTICA* L. 'JOJO' AND 'TOPHIT')

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Plum (*Prunus domestica* L.) is one of the most widely consumed fruit in the European countries. Plum, however, is a highly perishable product and has a short shelf life. In order to better retain fruit quality post harvest, methods such as cold storage or application of 1-MCP have been widely studied. Recently, edible coatings are also suggested to enhance the quality and shelf life of fruit. Edible coatings incorporated with additive as plasticizer could improve the properties through physical and chemical interactions. The aim of this study was to evaluate the effect of Versasheen (as edible coating) with sorbitol (as a plasticizer) on plum quality during storage.
Fruit, free of injury from diseases and insects, were harvested on a research orchard and treated with Versaheen (5 %) and sorbitol (0.2 %) before storage at 2 ± 0.5 °C (90 ± 2% RH) for up to 28 d plus 2 d at 20 °C. Every seventh d, fruit were randomly removed from the store and measured in 3 repetitions. Changes in fruit flesh firmness, color parameters (L*, a*, b*), soluble solids content (SSC), dry matter, pH, titratable acidity (TA) and transpiration rates were recorded.
During postharvest, changes in fruit quality related to fruit ripening, such as acidity losses, softening and transpiration were delayed by the use of edible coatings and sorbitol in comparison to uncoated ones (although 'Jojo' has been shown to better response to edible coating than 'Tophit'). No effect of edible coating on color change and SSC were found. Therefore, edible coating based on carbohydrate (Versasheen) and sorbitol could be effective tools to improve the preserving and storability of 'Jojo' and 'Tophit' plum.

CHANGES OF SELECTED ANTIOXIDANTS IN CARROT ROOT *DAUCUS CAROTA* L. OF DIFFERENT CULTIVARS DURING STORAGE

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Poland is the largest producer of carrot roots in Europe, where 60% is used for processing, combined with the storage of raw materials to bridge the accumulating yield. Carrot is high rated, primarily because of its excellent organoleptic properties and health benefits, which are determined by a number of factors, a.o. genotype and storage. The aim of the study was to investigate the changes of main antioxidants present in carrot root during storage in cultivars differing in their antioxidants composition.
The experiment involved 4 cvs: the yellow 'Mello Yello', the purple 'Deep Purple', and the orange 'Flacoro' and 'Karotan', cultivated under commercial conditions at the Experimental Station in Mochełek, UTP Bydgoszcz, in two consecutive years 2011-2012. After harvest, the carrot roots were stored in a chamber for 6 months at a temperature of +1 °C and a relative air humidity of 95-98%.
The conducted research revealed significant differences among the cvs with respect to yield, health promoting parameters, and large differences in the storage ability. The highest yield was observed for cv. 'Mello Yellow'. Cv. 'Flacoro' was characterized by the highest content of dry matter and the lowest amounts of antioxidants. Considering the health properties of cvs, the richest on antioxidants at harvest time was cv. 'Deep Purple', with the exception of carotenoids, which were highest in cv. 'Karotan'. However this cv. was unsuitable for long storage and characterized by the highest losses of nutritional and bioactive compounds during storage. Generally, the duration of storage significant impaired the contents of ascorbic acid, anthocyanins, carotenoids and polyphenolics, irrespective of cultivar.

THE EFFECT OF NANO-GRO PREPARATION ON THE YIELD AND THE ANTIOXIDANT PROPERTIES OF COMMON BEAN

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The effect of Nano-Groon the yield and the antioxidant properties of bean, Toska cultivar was studied. The experiment was carried out in 2012 and 2013. Nano-Gro was applied by seeds soaking, combination of seeds soaking and single spraying of plants, single spraying of plants and double spraying of plants. Four different variants of treatment with Nano-Gro were compared with the control. The number and weight of seeds, the number of pods and the weight of thousand seeds were recorded. Additionally, phenolics content (total phenolics, flavonoids and anthocyanins) and antioxidant capacity (radical scavenging capacity and reducing power) were determined. The application of Nano-Gro affected on bean yielding, phenolics content and antioxidant activity. It was found that combination of seed soaking and single spraying increasing the number and the weight of seeds and the number of pods. The highest weight of thousand seeds was found for double spraying. All variants of cultivation caused an increase of total phenolics content and anthocyanins. The best results were found for double spraying. Flavonoids content was the most effective increased by combination of seeds soaking and single spraying. An increase of phenolics was linked with a subsequent elevation of antioxidant capacity. In 2012, antiradical activity of beans was significantly increased by all modification of growth. An increase of reducing potential was obtained by double spraying.

EFFECT OF NITROGEN FERTILIZATION ON PRE- AND POSTHARVEST QUALITY OF SCALLOP SQUASH HARVESTED AT DIFFERENT STAGES OF FRUIT MATURITY

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Scallop squash (*Cucurbita pepo* L. var. *patissonia* Greb. f. *radiata*) is a vegetable crop species which fruits can be harvested at different stages of maturity. In terms of nutritional value and suitability for processing the small fruits with diameter 3-6 cm are better than those of bigger size and hard skin, which has to be removed before use. However, such fruits may be stored only for a short period of time, while the shelf life of fully developed ones may last even 2-3 months and supplied to the market beyond the growing season.

The objective of the study was to evaluate the effects of increased doses of nitrogen fertilization on yield, crop quality and shelf life of scallop squash fruits harvested after reaching the diameter of 3-6 cm, 6-12 cm, or > 12 cm. Nitrogen was applied at the rates of 60; 120 and 240 kg·ha^{-1} before planting in the form of ammonium nitrate. Scallop squash "Sunny Delight F_1" was cultivated from direct seed sowing in the half of May in 2011 and 2012. Harvest of small and medium size fruits was conducted in two, while fully matured ones in four day intervals.

Samples of 30 fruits for chemical analysis after harvest and separately for storage purpose were collected from each treatment at the most intensive period of yielding (end of July). During storage lasted 7, 14 or 21 days there was assured the stable temperature of 7ºC and relative humidity > 95%. On the average, the marketable yield of scallop squash gradually increased with the size of harvested fruits from 15.38 t·ha^{-1} to 46.16 t·ha^{-1} and 73.26 t·ha^{-1}, respectively. The enhancement of N rate up to 240 kg N·ha^{-1} was preferable for number of fruit setting and as a result of this the fruit yield, irrespective of the maturity stage at harvest. Plants supplied with 240 kg N·ha^{-1} produced fruits with the highest content of vitamin C, carotenoids, total N, sugars, as well as nitrates level, while 120 kg N·ha^{-1} was the optimal dose for dry matter and polyphenols.

Prolonged periods of fruit storage was associated with gradual decrement of dry matter content and their nutritional value, due to the diminishing amounts of vitamin C and polyphenols, while the enhancement of nitrates. Heavy nitrogen fertilization adversely affected the storage life of fruits causing the higher weight losses and drop of vitamin C, polyphenols and sugar contents. Irrespective of N dose, a good quality of small size fruits can be obtained only after short, lasted 7 days storage period, while fully developed ones during the whole evaluated period of 3 weeks.

COMPARISON OF LAMB'S LETTUCE STORAGE ABILITY TREATED WITH LED LAMPS AND SODIUM (HPS) ONES

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Leafy vegetables are the source of many valuable components like vitamins, minerals and phenolic compounds as antioxidants. Chlorophyll derivatives have antioxidant and anticarcinogenic activity, or may even be signalling molecules in organisms. However, during storage of the leafy vegetables in the cold and darkness numerous biochemical changes usually occur, such as the breakdown of chlorophyll. Storage abilities of the plant material are different and depend on the factors already influencing plants during cultivation.

Lamb's lettuce was grown in the greenhouse, plants were lighted with sodium (HPS - control) and LED lamps. The intensity of radiation at the height of the leaves of the plants were the same in every treatment, only emitted wavelengths were different. After harvesting, the plants were stored at temperature 5°C and high humidity in plastic bags. The analysis of the material was done 4 times: after harvest and three times at weekly intervals during storage. Fresh weight lost, dry matter, phenols and chlorophylls content were analyzed. Additionally the fluorescence measurements of chlorophyll *a* were carried out. Fluorescence is a good indicator of leaf senescence.

All leaves presented aging symptoms. Plants collected from the LED lamps plots characterized at least as good quality as from HPS ones. The use of LED lamps is justified due to lower energy consumption - lower cost of cultivation and threat to the environment - less radiation emitted outside the greenhouse, smaller waste production.

POSTHARVEST QUALITY OF ORGANICALLY GROWN LOWBUSH AND HALF-HIGHBUSH BLUEBERRIES IN MODIFIED ATMOSPHERE

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Our hypothesis was that the postharvest life of organically grown lowbush blueberry (*Vaccinium angustifolium*) and half-highbush blueberry (*V. corymbosum* x *V. angustifolium*) cultivar Northblue could be extended by using modified atmosphere (MA) packages. The aim of the study was to determine how MA packages affect blueberry quality. Fruits of different blueberry taxa were picked into 200-g perforated plastic punnets, cooled down to 3°C during 24 hours and packed as follows: 1) control, natural atmosphere (NA)– punnets covered with perforated lid; 2) 30 µm LDPE bag (low density polyethylene, product of Estiko, Estonia); 3) Xtend® blueberry bag (Stepac, Israel). Fruit dry matter, soluble solids, total anthocyanins content, titratable acidity, instrumental color (L*a*b*, C* and h*), firmness, shrivelling and decay were determined at harvest and after storage. O2 and CO2 content in the packages was measured nine times during storage. The experiment revealed that for lowbush blueberry, NA and LDPE bag were suitable only for 22 days storage. Xtend® package prolonged postharvest life up to 37 days for both blueberry taxa. CO_2 content was significantly higher in Xtend® film compared to LDPE at the end of storage. Content of organic acids and dry matter was higher in Xtend® film in both blueberry taxa, but firmness was better retained only in lowbush blueberry. Anthocyanin content of lowbush and half-highbush blueberry fruits increased significantly in all storage conditions. LDPE and Xtend package tended to suppress anthocyanin biosynthesis in lowbush blueberry, but this effect was not noticed in 'Northblue'.

Keywords: *Vaccinium angustifolium, V. corymbosum* x *V. angustifolium*, soluble solids, titratable acidity, anthocyanins, color

QUALITY OF TOMATOES CULTIVATED ON SUBSTRATES CONTAINING *TRICHODERMA* ISOLATES

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The aim of the research was to determine the influence of tomato cultivation in substrates containing the isolates of *Trichoderma* fungi on the quality of tomato fruits, their chemical composition and physical properties. The tomato greenhouse variety Growdena F_1 and four isolates of *Trichoderma* marked as the TR1, TR2, TR1+TR2 and TR-x were used in the experiments. Tomato cultivation was conducted in greenhouse, in prolonged cycle on rockwool slabs Grodan-Grotop. *Trichoderma* was applied to rockwool slabs as spore suspension three times at monthly intervals during the growing season after transplantation of tomato seedlings. The content of dry matter, ascorbic acid, total sugars, polyphenols, lycopene, nitrates as well as texture and color of tomato fruits were determined.
Tomato fruits from plants treated with *Trichoderma* were characterized by about 10% higher concentration of ascorbic acid in comparison to the control. The level of lycopene in tomatoes treated with isolates TR1 and TR2 was higher by about 50% compared to control. Polyphenol and nitrates concentrations in tomatoes treated with *Trichoderma* were similar to their content in control fruits. The level of nitrates in tomato fruits from the plants grown in the rockwool with *Trichoderma* was below 15 mgNO_3/kg. Degree of the maturity of tomatoes, expressed as intensity of the red color according to Hunter "a" parameter, was similar for all *Trichoderma* treatments. Texture measurements, according to Instron method, have also indicated the uniform maturity of tomatoes from cultivation with *Trichoderma* fungi and control treatment.

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EFFECT OF BLANCHING AND FREEZING ON FLAVONOIDS CONTENT IN BROCCOLI

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The effect of blanchnig, freezing and long term storage of frozen broccoli on flavonoids content in broccoli florets was studied. Two broccoli cultivars 'Naxos F_1' and 'Chronos F_1' grown conventionally were used in experiments. The small broccoli florets of 2 cm diameter were blanched in water of temperature 96-98 ^{o}C for 2.5 minutes, cooled in cold water and next packaged into nonperforated PE bags of 250 g capacity. Samples of broccoli were frozen in air at temperature -25 ^{o}C and next stored for 9 months in cold room at this conditions. Before flavonoid analysis frozen broccoli were lyophilized and homogenized to receive a homogenous material. Glycoside forms of flavonoids were extracted from broccoli with water solution of methanol (62.5%) and hydrolyzed with 2M HCL at 90 ^{o}C. HPLC analyses of flavonoids were performed using Agilent Technologies 1200 Series high performance liquid chromatograph equipped with Zorbax Eclipse XDB-C_{18} column and diode array detector DAD G1315B. A mobile phase of methanol and water (60:40%) adjusted with 0.2% H_3PO_4 was used for chromatographic separation of flavonoids. Analyses of flavonoids were performed for fresh broccoli, blanched and frozen material, as well as after 9 months of storage at -25 ^{o}C. Quercetin and kaempferol were found in fresh broccoli florets after harvest of both cultivars 'Naxos F_1' and 'Chronos F_1'. Total flavonoids content in fresh broccoli ranged between 205.0 mg kg^{-1} d.m. and 406.6 mg kg^{-1} d.m. depending on cultivar. After blanching quercetin content in broccoli has decreased by 46-91% and kaempferol by 58-75%. After storage of broccoli for 9 months at -25 ^{o}C there was found 8.0-17.1 mg. kg^{-1} d.m. of quercetin and 42.0-188.3 mg. kg^{-1} d.m. of kaempferol.

INFLUENCE OF HOT-WATER TREATMENT ON POSTHARVEST QUALITY AND SENSORY EVALUATION OF FRESH – CUT MUSKMELON (*CUCUMIS MELO* L.)

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The effects of treatment with hot-water on quality of fresh-cut muskmelon during storage at 0 °C, 5 °C and 18–20 °C were studied in this work. Imported melons (from Brazil) were bought from wholesaler. Before the experiment the whole fruits were kept at temperature 8 °C. Immediately before cutting, the fruits were washed, dried and peeled. Every fruit was cut into 14-16 pieces. Each sample (200 g) of cut melons was packed into polystyrene foam trays placed in crate lined with PE film. After cutting and during storage fresh-cut melons were analyzed for content of dry matter, vitamin C, total sugars, soluble polyphenols and nitrates. The sensory analysis of muskmelon fruit was performed on fresh fruit, treated with hot-water and stored at three levels of temperature. The quantitative description analysis (QDA) for the sensory analysis of muskmelon was applied. The trained panel of 10 persons generated a set of 11 descriptors for odour, appearance, texture and taste of muskmelon fruit.

Fresh muskmelons contained 7.5% dry matter, 5.1 mg/100g vitamin C, 5.8 % total sugars as well as 14.2 mg/100g soluble polyphenols and 2012 mg/kg nitrates. There was an increase in dry matter content in muskmelon stored at 18-20°C for 2 days or stored at 5 °C for 5 days after previous treatment with water at 55^{o}C for 3 seconds. Level of vitamin C and total sugars was not affected by hot water treatment and its storage at 18-20 °C or 5 °C and 0 °C. Soluble polyphenols content was significantly affected by hot water treatment and storage at 5 °C. Storage of cut muskmelon especially at 18-20 ° - regardless of the treatment, affected the decrease of nitrates content.

In sensory analysis, fresh muskmelon received the highest scores of intensive odour and typical taste for muskmelon or odour and taste of sweet fruit compared to samples treated with hot-water and then stored. Muskmelon treated with hot-water at 55 °C for 3 seconds and stored at 18-20 °C or 5 °C were characterized by high intensity of typical taste of fruit and received high scores for overall quality (respectively 7.11 a.u. and 7.67 a.u. on a arbitrary unit - scale from 0-10). The highest overall quality was found for non-washed muskmelon and stored at 0 °C. Results of this experiment shows that rotten and spoiled odour have influenced overall quality of muskmelon. Intensity of that descriptor was much more intensive in control muskmelon washed by water and stored at 18-20 °C.

EFFECT OF CONTROLLED AND MODIFIED ATMOSPHERE ON STORABILITY AND FRUIT QUALITY OF THIRTEEN PLUM CULTIVARS IN BELARUS

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The Republic of Belarus is carrying out the State Program of Fruit Growing Development (2011-2015) in 160 hectares of plums till the end of 2015 including 60 hectares for processing enterprises. At the same time there is a building of more than 120 000 tons storage capacities with different types of atmosphere.
The aim of the experiment was to test the effect of controlled and modified atmosphere storage on seven European and American plum cultivars of *Prunus domestica* L. ('Dalikatnaya', 'Narach', 'Venera', 'Vengerka belorusskaya', 'Volat' (Belarus), 'Stanley' (USA), 'Favorita del Sultano' (Italy)) and six hybrid plum cultivars of *xPrunus cerasifera* Ehrh.*, xPrunus salicina* Lindt. ('Asaloda', 'Lodva', 'Vetraz-2' (Belarus), 'Alyonushka', 'Kometa', 'Zolushka' (Russia)) which were grown in the experimental orchard of the Breeding Department of the Institute for Fruit Growing.
During 2011-2013 years plums were stored in four atmosphere types: normal atmosphere (NA), modified atmosphere (MA), standard controlled atmosphere with 5% CO_2 and 3% O_2 (CA) and controlled atmosphere with ultra low oxygen with 2% CO_2 and 2% O_2 (CA ULO) at 0±0,5 °C and +2±0,5 °C for two months at the Department of Fruit Storage and Processing of the Institute for Fruit Growing.
After storage percent of sound plums and incidence of storage disorders, weight loss, physical and chemical characteristics (soluble solids, firmness, springiness, level of endogenous ethylene) were determined. Then shelf life storage of sound plums was defined during two weeks at +18 °C.
After cold storage the best results were obtained with CA ULO at 0 °C for all plum cultivars. The maximal number of sound fruits was 92.4% for 'Stanley', 91.6% for 'Volat', 90.8% for 'Narach' among plums and 83.8% for 'Asaloda', 82.7% for 'Kometa' among hybrid plums.
80.6% for 'Stanley', 80.5% for 'Volat' and 67.9% for 'Kometa' into CA ULO at +2°C were selected respectively.
Among types of atmosphere the minimal weight loss was with modified atmosphere for all plum cultivars.
Level of endogenous ethylene was determined into MA. Prolongation of storage terms of plums deters by intensive accumulation of ethylene from the second week of storage.
At harvest date firmness of fruits were from 3.56 till 4.89 N/cm^2 for plum cultivars and from 2.27 till 4.18 N/cm^2 for hybrid plum cultivars.
After storage MA and CA made sure the maximal preservation of firmness.
The longest shelf life at +18 °C was observed for plum 'Stanley' and 'Volat', fruits (10 days) and for hybrid plum 'Zolushka' and 'Vetraz-2' fruits (14 days).
The results of the experiment show that fruits of European and hybrid plum cultivars in Belarus can be successfully stored in regulated atmosphere.

INFLUENCE OF DIFFERENT GROWING SYSTEMS ON STRAWBERRY CHEMICAL CONTENT IN LATVIA (TEMPERATE ZONE)

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These studies were undertaken to extend strawberry production season in Latvia for obtaining early, high quality fruits. The experiment was established in the Pure Horticultural Research Centre (Pure HRC), Latvia. Strawberries were grown on beds mulched with black plastic or without soil mulch in small tunnels covered by transparent polyethylene film or Agronet (Agryl 17). Three cultivars: 'Zefyr', 'Honoeoye' and 'Polka', were used. The fruit quality obtained in different cultural systems was evaluated two seasons. The effect of cultivar, plant cover, mulch and production year were investigated. The following chemical compounds were determined: content of ascorbic acid, titratable acidity, soluble solids, total content of phenols and anthocyanins, antiradical activity by DPPH (2.21- diphenyl-1-picrylhydrazyl) method, and radical scavenging activity (RSA) was calculated. The fruits for analyses were harvested at the maximum of production period. The samples were analyzed at the same day as harvested. Significant differences of chemical content within strawberry cultivars, production seasons and cultural methods were stated. Cultivar had the highest influence on the content of vitamin C, total phenols and RSA between the tested factors. The significant correlation between the amount of total phenolics and RSA was detected. The amount of anthocyanins was mainly influenced by plant cover, while the annual climatic conditions had the highest impact on the amount of titratable acidity and soluble solids. Soil mulching had the lowest influence on fruit chemical content.

EUROLEGUME - ENHANCING OF LEGUMES GROWING IN EUROPE THROUGH SUSTAINABLE CROPPING FOR PROTEIN SUPPLY FOR FOOD AND FEED

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A new colaborative project EUROLEGUME funded by the EC in the FP7 programme started in January 2014. The project is aimed to sustainable use of Leguminous plants and soil resources in order to ensure European citizens with balanced and safe food, ensuring the high quality protein sources in their daily diet by increasing competitiveness and cultivation of legumes for food and feed. The Project is focused in three leguminous species: pea (*Pisum sativum* L.), faba bean (*Vicia faba* L.) and cowpea/black eye-bean (*Vigna unguiculata* (L.) Walp). Short-term objectives of the Project are the following: 1. Evaluation of pea, faba bean and cowpea/black-eye-bean local genetic resources for the development of new varieties for food and feed and further use in breeding; 2. Development of new food and feed products from available European varieties of pea, faba bean and cowpea; 3. Selection of appropriate rhizobium strains and arbuscular mycorrhizae fungi to support nitrogen fixation and development of new, commercial inoculants; 4. Evaluation of influence of leguminous plants on the soil properties in sustainable, regionally specific cropping systems. 18 partners from 10 EU Member States joined to reach the aims of the Project.

INFLUENCE OF CONTROLLED ATMOSPHERE ON THE CABBAGE (*BRASSICA OLERACEA* VAR. *CAPITATA*) STORAGE QUALITY

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During the last decade the vegetable production in Latvia and in Lithuania has tendency to grow. Therefore qualitative long term storage facilities become topical problem for vegetable growers in Latvia. The solution is vegetable storage in CA. Cabbage was stored in CA atmosphere during the storage periods of 2010/2011 and 2011/2012 in the storage house of Pūre Horticultural Research Centre, Latvia. Storage room was equipped with ULO pallet system “Besseling”. Five gas composition variants were investigated during two storage seasons. The best results in the investigation were obtained by cabbage storing in the O_2 level between 2-5 % and CO_2 between 5 and 7 % in the season of 2010/2011.

THE APPLE ROOTSTOCKS INFLUENCE ON TREE GROWTH AND SURVIVAL

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During the last 15…20 years trees on vegetative propagated dwarfing or semi dwarfing rootstocks are planted in commercial orchards. Nevertheless it should be admitted that experience on vegetative propagated rootstocks in Latvia is relatively low, not always information about their suitability to local conditions, especially winter hardiness is available. There are analyzed several investigations conducted in Pūre Horticultural Research Centre during 2000 to 2013 for evaluation of dwarfing rootstocks in orchard. Several rootstocks of West Europe (M.26 M.9, M9 Burgmer 756, Jork 9), Poland (P2, P22 P59, P60, P61, P62, P66, P67), Russia (B.9, B.146, B.257, B.366, B.396, B.476, B.491) and Latvia (Pure 1) origin are included in these investigations. Cultivars `Auksis`, `Belorusskoye Malinovoye`, `Sinap Orlovskiy`, `Kovalenkovskoje` and `Ligol` are used. Influence of rootstock on tree surviving rate and vegetative growth is analyzed. Taking into account condition that several very critical wintering periods during the period of 2001 to 2013 were registered, the influence of rootstocks on tree survival and vegetative growth was analyzed. Insufficient level of surviving in Pūre climatic conditions is stated for rootstocks M.9, M.9 Burgmer 756, Jork 9, P2, P22 and P61. The reason of tree death usually is coincidence of several untoward conditions. Form the Polish breeding programme rootstock P67 is perspective in the Latvian conditions.

Key words: *Malus domestica*, cultivar, winter hardiness, temperature

CONDENSATION DYNAMICS IN PLASTIC FILM PACKAGING IN THE PERISHABLES SUPPLY CHAIN

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Many fruits, vegetables and fungi are highly susceptible to water condensation on their surface, which accelerates deterioration. Even at low temperatures and fluctuations of ambient air, condensation on relevant surfaces can be observed due to comparatively high air humidity inside the film packaging. The objective of this presentation is to explain the dynamics of condensation and its intensity within plastic packaging for fruit under changing environmental conditions. It will be shown that water condensation occurs time-delayed and superimposed with varying intensities on the surface of the fruit, on the inner film surface, and on the inner tray walls. Tests were carried out in experimental packaging with plums stored in a temperature-controlled climate chamber. Several temperature and rel. humidity sensors were placed inside and outside the packaging. The retention time of condensate at the inner film surface notably depends on in-package air volume. Increasing the volume, which, itself, is associated with increasing water-absorbing capacity of the air, causes lower retention times of condensate. In contrast, progressive air movement, close to the packaging film, increases retention times of water. Rising external temperature fluctuations are the source of increasing retention times at the film surface and higher intensities of condensate formation at the fruit surfaces. The dynamics of condensate forming, preferentially at the fruit surfaces, are characterised by the intensity of condensation. While the relative retention times of the condensate changed only marginally with respect to all test series, substantial changes were observed in the intensity of condensate formation at the fruit surfaces, in particular due to the duration of a temperature cycle.

THE INFLUENCE OF GROWTH REGULATORS ON YIELD AND QUALITY OF RAW MATERIAL OF *ALLIUM VICTORIALIS* AND *ALLIUM URSINUM*

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Long-rooted onion (*Allium victorialis* L.) and bear's onion (*Allium ursinum* L.) are valuable food and medicinal plants. They are endangered species. Little is known about their biochemical properties and cultural practices, which hinders possible cultivation.

Our research was aimed at studying the development dynamics for both species as well as their yield, seed productivity and contents of bioactive substances after the application of various growth regulators.

The experiment was carried out in 2008-2012 at the botanic garden of All-Russian Research Institute of Medicinal and Aromatic Plants and Russian State Agrarian (Timiryazev) University. Field trials were established in 2009 at sod-podzolic soils. Two experimental plots differed greatly in sunlight exposure.

Seeds were soaked for 24 hrs and vegetating plants sprayed with growth regulator solutions (Epin-extra, Circon and Ribav-extra) in certain concentrations. In the 1st year of experiments, the plants were treated thrice: when planted, during flower bud stage and at fruit set. In 2011 and 2012, the first application took place early in spring aftergrowing stage. Together with growth regulators, urea was applied to foliage. Controls were treated with water.

A significant increase (27-41%) in leaf yield in *A. victorialis* treated with Ribav-extra was observed. In *A. ursinum*, the leaf yield grew by 22-44% compared to the control. The use of Epin-extra and Ribav-extra helped to increase the number of dividing bulbs by 15% and flowering plants by 20%.

The maximal yield of both onion species was obtained from vegetating plants treated twice by Epin-extra and Circon; the weight of 1000 seeds was maximal in trials with Ribav-extra and Epin-extra.

Urea application together with growth regulators decreased ascorbic acid content in plants. In both species, Circon application maintained the ascorbic acid content in plants exposed to sun and Epin-extra – in shaded plants. Flavonoid content in bulbs of both species tended to increase at the end of the vegetation period regardless of growth regulators and was the highest in *A. victorialis*.

EFFECT OF MODIFIED STORAGE CONDITIONS ON THE MORPHOLOGICAL CHARACTERISTICS OF HAZELNUTS

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Hazelnuts are very valuable fruit as they contain large amounts of nutrients with the highest nutritional and biological value (apart from walnuts). For several years, they have been picked over a month earlier than the optimal harvest time for hazel trees. Therefore, immature hazelnuts as nuts in the seed cover are available on the market at the end of August. In order to extent the supply time period of this form of nuts from harvesting till Christmas when the sales are highest, they should be optimally stored like other fresh fruit varieties. In 2013, a study on the impact of storage conditions on the morphological characteristics of hazelnuts in the seed cover was conducted. The study was carried out with four hazelnut cultivars: 'Halle', 'Kataloński', 'Webba' and 'Cosford'. Hazelnuts were stored for 3 months, from harvesting in September until December, under the following conditions: NA (normal atmosphere), CA (controlled atmosphere) 3% O_2, 3% CO_2, MAP (Modified Atmosphere Packing bags) at 0-1 ˚C. The morphological features were evaluated after harvesting and storage and in a week after harvesting as well as after a 3-month storage period at 20 °C. The quality of fruits was assessed based on the mass of hazelnuts both with the seed cover and without, mass of the kernel, % of kernel in fruit mass, content of dry matter in the kernel and humidity of the kernel. In addition, the degree of adhesion between the nut and the seed cover and the degree of infestation with fungal diseases were investigated. The results demonstrated that all storage conditions had an effect on extending the freshness and durability of hazelnuts in the seed cover. The highest quality of hazelnuts was produced in the MAP storage system, although these conditions provoked a higher degree of infestation with fungal diseases. The examined morphological characteristics depended to a large extent on the cultivar.

EVALUATION OF FLESH FIRMNESS USING FTA DEVICE IN APPLES STORED IN ULO

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The aim of this study was to compare the flesh firmness of fruits of apple cultivars stored in different ULO atmospheres, based on measuring of the penetration by FTA instrument, and to find the decrease in flesh firmness of cultivars between the measurements in March and May. The experiment included apple cultivars (´Gala´, ´Jonagored´, ´Rajka´, ´Rubinola‘) stored in three ULO atmospheres with different concentrations of O_2 and CO_2 (1+1%; 2+2%; 1+3%) and a temperature of 1 °C. The penetration measurements were carried out on FTA (Fruit Texture Analyzer) device in March and May. The evaluation showed the most suitable atmosphere 1% O_2 + 1 % CO_2 for apple cultivars ´Gala´, ´Rubinola´ and ´Jonagored´, and 1% O_2 + 3% CO_2 for apple cultivar ´Rajka´ compared with less suitable atmosphere 2% O_2 + 2% CO_2. The lowest decrease of flesh firmness from March to May measurement was found in cultivar ´Rubinola´ in atmospheres 1% O_2 + 1% CO_2 and 1% O_2 + 3% CO_2 contrary to the highest decrease found in cultivar ´Rajka´ in all observed atmospheres.

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EFFECT OF FRUIT MATURITY ON CHLOROPHYLL FLUORESCENCE F-ALPHA OXYGEN STRESS SIGNAL

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The aim of the study was to determine the influence of the fruit maturity (analyzed with nondestructive methods) on achieving low oxygen stress detected by the chlorophyll fluorescence F-alpha (Fα) signal, using HarvestWatch™ (Satlantic Inc., Canada) dynamic controlled atmosphere system.
The experiment was carried out in 2013 on 'Gold Milenium' apples, 'Royal Glory' and 'Harrow Beauty' peaches and 'Conference' pears. The nondestructive measurements of fruit maturity (based on VIS/NIR methods) were performed at harvest using two instruments: DA Meter (Sinteleia, Italy) and CP Pigment Analyzer PA 1101 (Control in Applied Physiology GbR., Germany). The following indices were gathered: ΔA (DA Meter), NDVI and NAI (CP Pigment Analyzer). Besides the nondestructive measurements, the following maturity and quality parameters were measured: rate of ethylene and carbon dioxide production, background skin color, flesh firmness, total soluble solids content and titratable acidity. For apples and pears starch index was assessed and Streif index was calculated.
Fruits were divided into ripening classes based on the high/low values of ΔA index, or on respiration rate, in cases where small variability in the index was observed (pears). Significantly different classes of fruits were placed in the kennels equipped with the HarvestWatch™ FIRM sensors and moved to the controlled atmosphere chambers. Oxygen level in the atmosphere was gradually reduced until detection of a sharp, steady increase of the fluorescence signal Fα. After removing fruits from the storage chambers, aside from the assessment of the quality parameters mentioned above, the concentration of ethanol in fruits flesh (anaerobic respiration product) was measured (Senzytec 2, Italy).
The ΔA index correlated with NDVI for all fruit species/cultivars and for apples also with NAI. The assumption is that the ΔA is an index of the quantity of chlorophyll in a fruit and, as a consequence, of its ripeness state. Data from the experiment have shown that the ΔA values were closely related to fruits maturity parameters obtained from the destructive measurements.
The effect of fruit maturity on achieving the low oxygen stress detected by chlorophyll fluorescence Fα signal is not very clear, and based on the results of one year experiment it is difficult to draw general conclusions. For a better understanding of the examined relationship further research is needed. Additionally, it is necessary to improve the precision of the measurement of the oxygen concentration in the range where the stress induced increase of the Fα signal is observed.

The experiment was founded by the internal grant (statutory research project) of the Research Institute of Horticulture in Skierniewice, contract no DPN 30-2013.

ETHYLENE–ACTIVITY OF APPLE AND PLUM FRUITS DURING STORAGE, POSTHARVEST TREATED 1-MCP (SMARTFRESH^{SM})

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Post-harvest treatment of ethylene inhibitor 1-MCP increases the efficiency of fruit storage. The aim of the research was to determine the effect of postharvest SmartFresh^{SM} (1-MCP) treatment of apples (various ripening terms) and plums on the intensity of ethylene emission – an integral index of the level and direction of metabolism – during fruit refrigeration storage.

Plums Stanley and apples Calvil, Idared, Gloster, Golden Delicious, Granny Smith, Jonagold and Renette Simirenko were picked at a commercial harvest time. The fruits were cooled to the temperature of 5 °C and treated with 1-MCP (0.068 g/m^3, SmartFresh^{SM}) in an airtight container for 24 hours, then apples were stored for sixth months at the temperature of 2 ^{O}C and humidity 90-95% and plums were stored for 2.5 months at the temperature of 0 ^{O}C in a modified atmosphere (non-treated fruits – control).

The intensity of fruit ethylene emission was periodically measured with gas analyzer ICA-56 (International Controlled Atmosphere Ltd.) after a one- hour exposure of 0,5 kg of fruits, pre-heated to the temperature of 18-20 ^{O}C. 1-MCP depression index was calculated as the difference between number one and the result of the separation of the ethylene emission of 1-MCP treated fruit on a similar indicator of non-treated fruits.

It was established that post-harvest 1-MCP treatment of apples significantly affected the ethylene synthesis of fruits. During storage activity of ethylene emission by control fruits Calvil and Golden Delicious showed typical signs of climacteric with maximum rate on the 60th and 150th day of cold storage respectively, while the process intensity of plums and apples of other varieties only increased gradually. The highest activity of ethylene emission by control fruits – about 60 µl/kg·hr during climacteric was recorded for variety Golden Delicious (that for Calvil was 42.5), the lowest one was 4.4 µl/kg·hr for variety Idared.

The change of ethylene activity of early-winter apple variety Calvil, treated with 1-MCP after harvesting, has exponential character, especially actively growing after two months of storage – up to the level of 18 µl/kg·hr at the end of six-month storage. A similar dependence was found for winter variety Jonagold with the indicator which is three times lower than the highest one - 6 µl/kg·hr, and for plum fruits stored for 2.5 months in a modified atmosphere. At the same time a level of ethylene activity of 1-MCP treated fruits of other apple varieties increased steadily to a level of only 0.36 … 1.55 µl/kg·hr.

The index of inhibitory action of postharvest 1-MCP treatment confirms the consistent restoration of the ability to ethylene synthesis and thus to post-harvest ripening of apples (cvs. Jonagold, Gloster, Idared and especially Calvil) and plums. At the same time, ethylene synthesis of fruits of other apple varieties is effectively suppressed during the whole six-month period of refrigeration storage.

Therefore, post harvest treatment of apple fruits with ethylene inhibitor 1-MCP (coming from product SmartFresh^{SM}) reduces significantly ethylene activity of winter apple varieties during refrigeration storage, and it has smaller effect on plum fruits and apples of early winter variety Calvil.

The authors express their gratitude to "AgroFresh" (Poland) for providing “SmartFresh^{SM}” preparation and ICA-56 device to carry out trials.

CHEMICAL COMPOSITION OF SELECTED RED FLESHED APPLES

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In many countries there is an interest in red fleshed apples and new such cultivars are developed through selective breeding. Now several splendid culinary fruits with red flesh are available. Moreover some of these cultivars are suitable to Columnar Apple Tree System (CATS) training. This system allows intensifying yield, simultaneously being in harmony with nature. These apples, on the contrary to white or yellow flesh apple cultivars, contain in the flesh anthocyanin compounds, which are strong antioxidants. Red fleshed cultivars are an interesting material for processing due to red or pink colour of the products obtained. However, there is still scanty information on their quality. The aim of our study was to analyze physical, chemical and sensory qualities of selected cultivars: 'Trinity', 'Alex Red' and 'Maepole' and to compare them with the standard apple cultivars: 'Shampion' and 'Idared'. The analyses were conducted for 3 seasons: 2011-2013.

The investigated red-fleshed apples were characterized by an average soluble solids content and high acidity in comparison to the control cultivars: about 2-3-times higher in relation to 'Idared' and 3-6-times higher compared to 'Shampion'. The high acidity of these cultivars was due to high content of malic acid (1336-1970 mg/100 g). In consequence the red fleshed apples had low ratio of soluble solids to acidity 6.8-10.0 – that is why these fruits are not acceptable for consumption in the fresh state. 'Maepole' possessed the highest amount of phenolic compounds and the predominant compound was chlorogenic acid. On the other hand, this cultivar had the lowest antioxidant activity ($ABTS^{\bullet+}$). It was found that the red fleshed apples contain considerably less catechins and oligomers of proanthocyanins in comparison to the control apple cultivars. The anthocyanins content was in the range from 46.3 to 216.5 mg/kg. 'Trinity' was the most abundant in anthocyanins.

BIOCHEMICAL CONTENT OF LEAVES OF GREEN AND SALAD CROP

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Currently, the global market more and more pays attention to green and salad crops. These crops belong to valuable vegetables in terms of its high nutrition and taste qualities, as well as a short growing period. Fresh consumption of green vegetables covers requirement in minerals and vitamins. In addition, chlorophyll as a basic substance of all green parts of plants inhibits growth of pathogenic bacteria and contains a lot of magnesium, which improves blood flow to the heart muscle and it is involved in the formation of bone tissue [Surai, 2003].

In the investigation reported here, we examined the content of ascorbic acid, total antioxidants content, carotenoids, chlorophylls *a+b*, dry matter and potassium in the leaves of rocket (*Eruca sativa* Mil.) cv. 'Rusalochka', garden cress (*Lepidium sativum* L.) cv. 'Prestig', mustard (*Brassica juncea* (L.) Czern.) cv. 'Volnushka'.

The maximum of total antioxidant content was found in the leaves of mustard (84.6±2.9 mg/g AAE). In the leaves of rocket and garden cress the total antioxidant content was lower (68.4±0.5 mg/g and 47.3±1.0 mg/g GAE). The content of ascorbic acid was higher in the leaves of rocket (1.6±0.2 mg/g), mustard (1.1±0.1 mg/g) and garden cress (0.7±0.1 mg/g).

The leaves of mustard were characterized by maximal dry matter (16.7± 0.1%). The minimal amount of dry matter (12.9±0.3%) and maximal amount of potassium (307.6±7.3 mg%) was found in the leaves of garden cress.

The content of carotenoids in the leaves of all crops was similar (0.20±0.01 mg/g). The contents of chlorophylls a+b in the leaves of garden cress and mustard were maximal.

Salad and green crops are multifunctional crops, which have great potential for combating malnutrition.

RELATIONSHIP BETWEEN TEXTURE SENSORY PROFILES AND OPTICAL PROPERTIES MEASURED BY TIME-RESOLVED REFLECTANCE SPECTROSCOPY DURING POST STORAGE SHELF LIFE OF 'BRAEBURN' APPLES

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The aim of this reasearch was to study the relationships among optical properties measured by time-resolved reflectance spectroscopy (TRS) and apple texture characterized by sensory profiling (firm, crispy, juicy, mealy) and instrumental analysis (firmness, stiffness and energy-to-rupture) after 6 months storage in controlled atmosphere. 'Braeburn' apples from three harvest dates were measured by TRS for the nondestructive maturity index μ_a670, ranked on the basis of decreasing μ_a670 (increasing maturity) and classified as less (LeM), medium and more mature (MoM). Then fruit were randomized into 3 batches of 30 fruit/harvest and LeM and MoM apples were analysed after 1, 8 and 14 days of shelf life at 20 °C in the 630-900 nm range by TRS, for sensory profile and for mechanical characteristics of the pulp. According to sensory intensity scores, fruit were either divided into 5 classes (very low, *VL*; low, *L*; medium, *M*; high, *H*; very high, *VH*) separately for every attribute, or clustered into four groups, each one representing a specific sensory profile. Data of mechanical and sensory characteristics and of optical properties were processed together by Principal Component Analysis. The absorption spectra showed a maximum at 670 nm (chlorophyll-*a*) and μ_a670 was significantly higher in the *VH* class for firm, crispy and juicy and in the *VL* and *L* classes for mealy. The scattering spectra had a decreasing trend with the wavelength increase, and μ'_s values were significantly lower in the *VH* class for firm and crispy, and higher in the *VH* class for mealy and in the *VL* ones for juicy. Four principal components (PC) were selected explaining 85.5% of total variance. In PC1 μ'_s values were negatively related to firmness and μ_a670, and in PC2 μ_a690, μ_a730, μ_a830, μ_a850 and μ_a900 were opposed to mealiness. PC scores significantly differed among the four sensory profiles and significantly increased from *VL* to *VH* classes for firmness, crispiness and juiciness and from *VH* to *VL* classes for mealiness.

THE INFLUENCE OF TIME AND STORAGE CONDITION ON LEVEL OF INDOLE-3-CARBINOL AND SULPHORAPHANE IN BRUSSELS SPROUT

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Brussels sprout is one of the cruciferous vegetable and have potential protective role in cancer disease. *Expected anticancer* agents are indole-3-carbinol and sulphoraphane. Conducted experiments show that both of that components are able to mediating chemopreventive activity in animal.
The aim of the study was to evaluate the influence of condition and time of storage on indole-3-carbinol and sulphoraphane content in two cultivars of brussels sprout Louise F_1 and Ajax F_1. Indole-3-carbinol and sulphoraphane were determined by the HPLC method using the Agilent Technology Chromatograph Infinity 1260 equipped with UV detector, column Eclipse XDB-C18 (4.6× 150 mm, 5 µm). The separation was carried out at 30 °C. Using gradient elution at a flow rate of 1.0 ml/min; the mobile phase of acetonitrile and H_2O (80%:20%).
In three storage seasons determination of indole-3-carbinol and sulphoraphane was conducted.
Brussels sprout after 12 weeks storage at controlled atmosphere had lowest level of both compounds. Higher amount of indole-3-carbinol and sulphoraphane was determined in Ajax F_1 cultivar, stored at temp. -1.5 °C and 0^{o}C (19 µg/100g) than in temp. 5 ^{o}C (10 µg/100g). Completely decay of sulphoraphane after 12 weeks storage occurred in each temperature.
More of indole-3-carbinol was found in brussels sprout cultivar Louis F_1 stored at temp. -1.5 ^{o}C (63 µg/100g) than at 0 and 5 ^{o}C (32 and 22 µg/100g). Amount of indole-3-carbinol in cultivar Louis F_1 stored at controlled atmosphere was lower (101 µg/100g) than in control (113 µg/100g). Greatest amount of sulphorafane was determined in brussels sprout stored at -1.5 ^{o}C (131 µg/100g).

ANALYSIS OF VOLATILE ORGANIC COMPOUND PROFILES AS MARKERS FOR QUALITY OF FRESH CUT FRUITS

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Ready to eat partially processed fruits and salads are increasingly popular and provide easy access to fresh fruit and vegetables. Melons are an important component of fresh fruit salads, prized for their characteristic aroma, however they suffer from limited shelf life. Processing of melon fruit for use in fruit salads induces changes in flavour (sweetness) and aroma (production of volatile organic compounds –VOCs). We are interested in using VOC analysis to obtain markers for assessing quality and safety of fresh ready to eat fruit salads and to provide an useful tool for the industry. Several methods are available for capture and analysis of VOCs; we have chosen to collect VOCs from headspace on thermal desorption tubes (TD) and to analyse them after thermal desorption on Gas Chromatography and Time of Flight Mass Spectrometry (TD-GC-TOF-MS). *Cucumis melo* L. var. Arapaho and var. Pregiato (cantaloupe melon) were obtained commercially, and selected for uniformity and maturity based on colour, appearance and waxy development at the stem end. We investigated the influence of transport, cut size, and temperature on composition of VOCs in the head-space during storage. We were able to identify the major volatile compounds associated with melon aroma and show significant changes in the overall VOC profile during storage at 2 different temperatures. We were also able to discriminate VOC profiles from the different cut sizes. Results indicate that VOCs can provide useful non-destructive markers for assessing quality.

AIR TEMPERATURE INFLUENCE ON BLUEBERRY BIOCHEMICAL COMPOSITION

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Blueberries are tasteful fruits and are widely believed to be the source of health beneficial compounds, especially phenolic. The objective of the research was to assess the biochemical content of blueberry fruits grown in Latvia. Seven cultivars of highbush blueberry *V. corymbosum* L. ('Duke', 'Spartan', 'Patriot', 'Bluejay', 'Blueray', 'Bluecrop', 'Jersey') and four cultivars of half-highbush blueberry *V. corymbosum* × *V. angustifolium* ('Northland', 'Northblue', 'Chippewa', 'Polaris') were analyzed for total phenol, total anthocyanins, ascorbic acid, soluble solids and titratable acid content in frozen berries. The blueberry fruit were harvested from blueberry collection of Institute of Agrobiotechnology in 2008, 2010 and 2011. The chemical composition analyses were carried out at the Latvia State Institute of Fruit-Growing. The results showed that the sum of the effective temperature in production period had a significant effect on the biochemical composition of the berries over the year (especially on the content of ascorbic acid). Significant negative correlations indicated that with the increase in the sum of effective temperatures the content of ascorbic acid, soluble solids and titratable acid in berries decreased. In certain observation years (2008 and 2011) ascorbic acid, soluble solids and titratable acid content in berries was affected also by the average daily temperature in the production period.

Key words: highbush blueberry, anthocyanins, phenolic, ascorbic acid, soluble solids, titratable acidity

INFLUENCE OF CLIMATIC CHANGES ON MATURATION, YIELD AND CHARECTERISTICS OF KEITT MANGO *(MANGIFERA INDICA* L.) FRUITS

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Climatic factors, especially temperature and light intensity, have a strong influence on composition and nutritional quality of fruits and vegetables. The present study was aimed to investigate the impact of changes in some climate factors include temperature, relative humidity (RH) and light intensity on maturation, yield and characteristics of mango fruits.

To investigate the changes in climatic factors; mango plantlets were transplanted under two different conditions which are: open field and net cover (30% shade). All plantlets were grafted on balady rootstock, grown in sand soil in an orchard located at Elboseily region, Beheira governorate North West Egypt and subjected to similar agricultural practices. Seven years later, the present study has been carried out.

The results showed that the higher the temperature (in open field) during the growing season, the sooner the fruit maturation. Fruit weight, pulp% and yield were significantly higher in shaded fruits. Total soluble solids (TSS), total carotenoids and ascorbic acid were higher in open field fruits.

Key words: Climatic factors - light intensity – Shade – Carotenoid – Yield.

LIMITING THE DETERIORATION OF LOQUAT FRUIT BY SOME ANTI OXIDANTS DURING STORAGE AT ROOM TEMPERATURE

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As a result of physiological changes and senescence, susceptibility of loquat fruit (*Eriobotrya japonica* Lindl.) to postharvest diseases increases during storage at room temperature. The present study was aimed to investigate the effects of postharvest dipping in some anti oxidants on the physiological changes and the incidence of decay during storage at room temperature. Freshly harvested loquat fruit were treated with four treatments which are: tap water (control), 5 mM salicylic acid (SA), 2000 ppm ascorbic acid (AA) and 5 mM citric acid (CA). All fruit were dipped in the prepared solution for 5 minutes, air dried and stored under room conditions (18±2°C and 55% RH). Respiration rate, TSS, total acidity (TA), firmness, weight loss and decay were evaluated three days interval. The results showed that postharvest treatments with anti oxidants specially SA slowed down the respiration rate and weight losses, maintained higher levels of fruit firmness, and delayed the incidence of fungal diseases.

Key words: salicylic acid- decay- weight loss- respiration- postharvest diseases.

MICROBIAL QUALITY OF FRESH-CUT VEGETABLES TREATED WITH HOT WATER

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The fresh-cut vegetable market has shown fast growth in recent years. Fresh products, eaten raw and minimally processed are important components of a daily diet. However, raw vegetables can harbor many microorganisms, which may be dispersed during washing, cutting or peeling prior to the sale of the fresh-cut products. The contamination with spoilage or pathogenic microorganisms increases during storage. They are the cause of food decay and reduce shelf life of fresh-cut vegetables, and potentially may be a source of foodborne illness. Washing is an important step in produce hygiene reducing soil, dirt and partially contaminating microorganisms. However, microbial cells can attach to the plant surface and are difficult to remove even by vigorous washing. The use of chemicals to extend postharvest life of vegetables has become not accepted by consumers. Heat treatments as such hot water are non-chemical methods that have been used to control microorganisms and senescence-related symptoms of fresh produce. The aim of the study was to investigate the effect of different hot water treatments of fresh-cut preparations of chinese cabbage and rocket on microbial growth under different storage conditions. Fresh samples of cabbage were cut into small pieces and washed in tap water or in water heated at 40 ^{o}C for 10 minutes or at 53 ^{o}C for 3 seconds. Rocket leaves were washed in tap water or treated with water heated at 55 ^{o}C for 3 seconds. Non-washed plant material was used as control. After treatment the vegetables were dried, cooled to equal temperature and packed into polystyrene foam trays, kept in plastic containers lined with polyethylene film. The cabbage was stored for 3 days at 18–20 ^{o}C, for 7 days at 0 ^{o}C, and for 7 days at 5 ^{o}C. The rocket was stored for 4 days at 18–20 ^{o}C, for 10 days at 1 ^{o}C, and for 10 days at 5 ^{o}C. For microbial analyses the samples of cabbage and rocket were homogenized in sterile buffered peptone water using filter stomacher bags. Then serial dilution method on appropriate selective media was used to examine microbial growth in plant material. The following groups of microorganisms were studied: mesophilic bacteria, coliforms, *Escherichia coli,* molds and yeasts. In all experiments cutting and washing of plant material had no significant effect on the number of microorganisms directly after treatments, before the storage. It showed that washing, even in heated water, had not reduced significantly the density of microbial cells on plants. After storage of the cabbage the number of mesophilic bacteria, coliforms, molds and yeasts increased rapidly in washed samples. *E. coli* was not detected. Heated water generally did not reduce these microorganisms. Similar effect was observed for rocket. However, in this case treating of the leaves with heated water stimulated growth of the microorganisms compared to washing in tap water, especially in the samples stored at higher temperatures (5 ^{o}C for 10 days and 18–20 ^{o}C for 4 days). Lower storage temperatures inhibited growth of coliform and fungi on the rocket as well as on cabbage. The mesophilic bacteria were more resistant to lower temperatures, especially on cabbage. The best temperature to inhibit microbial development during storage of fresh-cut vegetables was 0- 1 ^{o}C.

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POLLINATOR INFLUENCE ON CRANBERRY (*VACCINIUM MACROCARPON* AIT.) YIELD AND QUALITY

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The American large-fruited cranberries (*V. macrocarpon* Ait.) have become over the last 15 years some of the most popular berries grown in Latvia. Cranberries occupies 130 hectares in Latvia, but the future is planned to increase plantations.
Pollination is the planned work, which are destined to increase crop yields. Bumble, bees and other wild pollinators are more important for crop pollination than previously thought. These studies are not continued in Latvia for the last fifty years. The experiment was carried out at the Institute of Agrobiotechnology, Latvia University of Agriculture, Jelgava, in years 2010 to 2013.
The aim of this experiment was to evaluate the effects of the pollinators on the cranberry berries yield. The bumble bees (*Bombus terrestris*) and bees (*Apis mellifera*) were used as pollinators in the trial three cranberry cultivars 'Stevens', 'Bergman' , 'Lemonyon' and 4 different variants-field (open + covered + bumble bees + bees) were employed. The results showed that cultivar 'Stevens' in years 2011 and 2012, and 'Lemonyon' in years 2010, 2011 and 2012 were higher yield when as pollinator used bees. Cultivar 'Bergman' in 2011 and 2013 higher yield was when as pollinator used bumblebees. The results showed differences on 100 berry weight between cultivars. 'Steven' 100 berry weight increased with pollinator bumblebees (2010 – 12%, 2012 – 17%), but 'Lemonyon' and 'Bergman' 100 berry weight and yield were higher with both pollinators: bees (2010 – 22%, 2013 – 31%) and bumblebees (2012 – 8%, 2013 – 13%).

Key words: cranberry, pollination, yield, bees, bumble bees

IMPACT OF UV-C IRRADIATION AND SIMULATED SALE CONDITIONS ON THE HEALTH PROMOTING PROPERTIES OF RASPBERRY FRUITS (RUBUS IDAEUS L.) CV. 'POLKA'

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The major cause of post-harvest losses in stored raspberry fruits is the development of fungi, mainly of grey mould (*Botrytis cinerea*). Since the use of fungicides and post-harvest treatments are restricted by legislation, there is a growing demand for new techniques such as the application of UV-C, which can reduce fungal growth, not leaving any residue on the treated products and ensuring quality maintenance.
The objective of this study was finding and understanding the effects of a hormic dose of UV-C on the quality of raspberry fruits under simulated sale conditions.
Experiments were conducted during two growing seasons in 2012 and 2013, where the raspberry fruits of cv. 'Polka' were subjected to UV-C irradiation in a treatment chamber constructed by one of the authors. The application time ranged from 0 to 24 minutes with steps of 2 min. Simulated sale conditions after irradiation consisted of a temperature of 24 °C and 70% relative air humidity for 4 days. Investigations comprised analyses of weight loss and contents of ascorbic acid, total polyphenolics, chlorogenic acid, and anthocyanins.
The conducted research revealed that the UV-C application was most effective when applied for 18 and 20 min and did not negatively influenced fruit mass. After irradiation higher contents of chlorogenic and ascorbic acid as well as of total polyphenolics were observed at 8 and 12 min. Storage time negatively affected fruit weight (loss of up to 23-25%) and increased the content of total polyphenolics. In the case of ascorbic and chlorogenic acid the highest contents were determined at the 2nd day of storage.
Generally, the application of UV-C improved the quality of raspberry fruits under simulated sale conditions and represents a promising method for fruit preservation, which can be easily applied at field conditions.

EFFECT OF SUPPLEMENTAL LIGHTING WITH THE MODERN SSL LED TECHNOLOGY ON THE ASCORBATE-NITRATE INDEX IN LAMB'S LETTUCE LEAVES IN AUTUMN AND WINTER SEASON

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This study was undertaken because of the growing interest in alternative sources of light in horticultural cultivations that compared to high pressure sodium lamps are more durable, environmentally friendly and cost-effective in view of energy consumption. Such opportunities provide LED lamps which additional advantage is the setting of radiation range, important for plant physiology and quality parameters of the yield. The experiment was conducted in a greenhouse of the Faculty of Horticulture, University of Agriculture in Krakow, in two growing seasons (2012/13): autumn and winter. Lamb's lettuce (*Valerianella locusta*) plants were lighted with LED lamps in modern SSL LED technology. The experiment included five treatments: four with LED lamps (LED 1-4 differing with spectral composition of the emitted light) and one with HPS lamps. Chemical analyzes were carried out after 60 days of supplementary lighting (16h day/8h night), that was, in harvest day. In both seasons the smallest concentration of ascorbic acid was demonstrated in leaves of plants lighted with sodium lamps. In autumn cultivation the highest I_{AN} (ascorbate-nitrate index) value was found in lamb`s lettuce growing under LED lamps (LED 2, subsequently LED 4) – and in the winter – LED 4, 2 and 3. Significant differences in the total nitrogen content were also observed. Lamb`s lettuce leaves collected in mid-December accumulated significantly lower content of nitrates than in mid-February, irrespective of light treatment. As a result a significantly higher value of I_{AN} was observed in autumn. Results of the experiment indicated the usefulness of the SSL LED technology in improving the selected quality parameters of the obtained yield.

LABORATORY EFFECT OF DIFFERENT DERIVATIVES OF SAVORY (*SATUREJA HORTENSIS* L.) ON GROWTH OF HARMFUL FUNGI

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Synthetic chemical fungicides are effective, however, toxic for environment, people and animals. Natural plant substances may be alternatives for them. The aim of this work was "*in vitro*" estimation of antifungal activity of essential oil, hydrosol and dried powdered material obtained from savory, cultivated on an experimental field near Szczecin.

The essential oil was extracted from dried, ground herb by hydrodistillation method. The hydrosol was a by-product of hydrodistillation and the powdered material was obtained from aerial-dried herb, grounded to pass through 1.0 mm sieve. Their antifungal activity was tested against *Alternaria alternata, Apergillus niger, Botrytis cinerea, Cladosporium herbarum, Fusarium oxysporum, Penicillium cyclopium, Trichothecium roseum.* A disc diffusion method was used to assess the oil activity (diameters of mycelium inhibition growth were measured). A "poisoned medium" technique was used to estimate the hydrosol and the powdered material activity (% inhibition of fungal growth was calculated). Distillated water and Topsin (thiophanate-methyl) were used as controls. Measures were made on the 3rd, 6th, 9th and 12th day of incubation. A composition of the oil was analyzed by gas chromatography. Total phenols content was estimated in the powdered material and hydrosol. It was stated that carvacrol was the main component (70.5%) of the oil. The powdered material and hydrosol had 5.1 and 0.38% of polyphenols, respectively. Antifungal activity decreased during incubation time and depended on a kind of derivatives and strain of fungus. On the last day of observations, mean diameters of inhibition of fungi growth, caused by the oil (10µl/disc) ranged 10-65 mm. The powdered material (dose 1.5%) inhibited fungi growth by 52-100%. Both derivatives were especially effective against *B. cinerea*, *C. herbarum* and *T. roseum* and their action against *P. cycopium* and *A. niger* was weaker. The hydrosol (dose 30%) slightly inhibited only the growth of *A. alternata, T. roseum, F. oxysporum* and stimulated the growth of other fungi. Topsin was less active against test fungi than oil and powdered material.

The results show a potential possibility of using the essential oil and powdered material, obtained from savory herb, as natural fungicides. However, further "*in vivo*" research is needed.

THE EFFECT OF POSTHARVEST TREATMENT ON QUALITY AND SENSORY CHARACTERISTICS OF RUCOLA (*ERUCA SATIVA*)

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The influence of postharvest hot-water treatment of rucola leaves (*Eruca sativa*) on their quality and sensory characteristics after short term storage was investigated. The plants were cultivated conventionally at the Research Institute of Horticulture, Skierniewice. After harvest rucola leaves were treated by hot-water at the following conditions: 53 °C – 5 seconds, 45 °C – 20 seconds, and 55 °C – 3 seconds. Also rucola treated with tap water at room temperature was included in investigations, while rucola leaves untreated with water were considered as a control. After treatments of rucola leaves were dried and packed into polystyrene foam trays placed in crates lined with PE film. Rucola was stored at three levels of temperature: 18-20 °C for two days, 5 °C and 1 °C for ten days. The fresh rucola and stored one after water treatments were analyzed for content of dry matter, vitamin C, total sugars, soluble polyphenols, nitrates and antiradical activity. Sensory quality of rucola was evaluated for odour, texture and taste by a trained panel using the quantitative description analysis (QDA).
The fresh rucola was characterized with better overall quality compared to samples treated with hot-water and stored. Results of experiments shown the off-odour and off-flavour in assessed rucola leaves after their harvest. Rucola leaves washed in tap water received the best overall quality after storage at 5 °C and 1 °C (respectively 7.55 a.u. and 7.37 a.u. – scale 0-10 arbitrary units) than other samples. Rucola treated with hot-water at temperature of 55 °C for 3 seconds and stored at temperature 18-20 °C and 1 °C was characterized by the lowest scores of overall quality (respectively 5.17 a.u. and 4.82 a.u.) due to high intensity of off-odour and off-flavour described as rotten and spoiled leaves.
Fresh rucola was characterized by a high content of vitamin C 108 $mg \cdot 100g^{-1}$ FW, polyphenols 111 $mg \cdot 100g^{-1}$ FW and nitrates 2200 $mg \cdot kg^{-1}$ FW. An increase in dry matter and vitamin C content was noted in rucola after water treatment and following storage at all temperatures. The highest content of vitamin C was found in stored rucola treated with tap water. Treatment of rucola with water at 45 °C for 20 seconds resulted in highest increase of soluble polyphenols in leaves. All treatments significantly affected the antiradical activity of stored rucola. The highest losses of total sugars were observed in rucola treated with water at 55 °C for 3 seconds and then stored at 5 °C for 10 days.

SENSORY QUALITY OF PEPPER FRUIT GROWN IN SOIL WITH ADDITION OF *TRICHODERMA* FUNGI

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Different species of *Trichoderma* fungi are well known to antagonize pathogens, to promote plant growth and to increase yield. Cultivation of pepper plants in soil added with selected *Trichoderma* strains grown on organic carrier resulted in enhanced yield and fruit marketable value. The aim of presented studies was to assess the sensory quality of the fruits. The experiment was conducted in the year 2012. Plants of sweet pepper cultivar Olvera F_1 were grown in soil amended with single strains of *Trichoderma* or with their mixtures on organic carrier, in unheated tunnel. Control plants were grown at the same conditions in soil without additions and with soil amended with organic carrier only. The fruits for sensory analysis were collected after harvest. The analysis was conducted by using the quantitative description analysis (QDA). The trained panel, consisted of 10 persons, generated a set of 13 descriptors for odour, appearance, texture and taste of pepper fruit.
During the experiment a few trends related to the effects of *Trichoderma* treatments on the quality of pepper fruits were observed. Control fruits and the peppers from the plants grown in soil with organic carrier only received definitely lower scores of the quality compared to objects with treated with *Trichoderma.* Generally there were not significant differences in sensory quality of the fruits between the objects treated with different strains of *Trichoderma*, single or mixtures. The fruits from the object designed as TRS 12, where the mixture of two *Trichoderma* isolates was used, were characterized by the best crunchiness and juiciness of the flesh, the sweetest taste intense, and the best overall quality. In addition, the fruits from this object received the lowest scores of sour taste compared to the other samples. Results of the experiment showed off-odour and off-flavour in assessment of pepper fruit. The results were confirmed by the analysis of variance.

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THE EFFECT OF IRRIGATION ON THE CONTENT OF ASCORBIC ACID AND ANTIOXIDANT ACTIVITY OF LEAFY VEGETABLES

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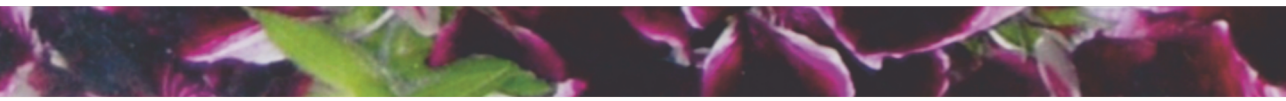
Leafy vegetables are a good source of dietary fiber, antioxidants, phytonutrients, provitamins, polyphenols, and minerals. Currently consumers more and more are thinking about a healthy and balanced diet. The aim of the research was to evaluate the effect of irrigation on the content of ascorbic acid and antioxidant activity in lettuce cv.'Grand Rapids' and leafy mustard cv 'Scala'. Experiments were arranged in high plastic tunnels of Pūre Horticultural Research Centre during spring and autumn of 2013. Plants were grown in 3 replicas, total area of each experimental plot – 1 m^2. As control was used variant with optimal soil moisture, as experimental plot- with moisture deficit. Available for plants moisture in the soil was detected by tensiometers. The content of ascorbic acid was determined by using titration with 2,6-dichloroindophenol in acidic solution. Antioxidant activity was determined by using the DPPH assay. The higher ascorbic acid content and antioxidant activity was detected in the control variant with optimal soil moisture.



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