

**S11**

## ISAFRUIT: INCREASING CONSUMPTION OF FRUIT BY MEETING CONSUMER NEEDS – SCIENCE OVERCOMES THE BOTTLENECKS

**S11.001**

### Societal and Consumer Acceptance of Food Technologies

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Historically, communication with consumers about food issues associated with health and environmental impact has focused almost exclusively on food risks, while health benefits have been communicated separately, as nutritional information. Other areas relevant to consumer food choices (for example, innovations in food production technologies) may also involve consumers “trading off” perceived benefits (for example, improvements to consumer health, or more sustainable production) against perceived risks, (including uncertainty regarding long-term effects, or ethical concerns about the technology). In reality, consumer food consumption decisions frequently involve weighing risks against benefits. Indeed, integrated assessment of risk and benefit is increasingly forming an integral part of the assessment phase of risk analysis. In the context of new technologies applied to fruit production, it is important to understand how consumers perceive risks and benefits associated with both product and process, as well as identifying individual differences in preferences for specific benefits and communication strategies. The determinants of consumer attitudes towards food technologies will be reviewed. A case study will be presented. Consumer perceptions of the use of different agrifood technologies (nanotechnology, genetic modification, “conventional” production, and organic production), and the impact of risk-benefit information on subsequent consumer attitudes were examined. The results suggest that risk information tends to have a greater impact than benefit information on attitude formation under conditions where attitudes are uncrystallised. Once formed, attitudes are difficult to change. In the case of emerging technologies, people’s attitudes may be guided by perceptions of “shared values” with opinion leaders. Scientific understanding regarding how consumers perceive risks and benefits, together with further understanding of the cognitive processes underlying risk-benefit communication, and associated decision-making regarding food choices is needed. This knowledge will form the basis of effective risk-benefit communication strategy associated with nutritional and technological food issues across a range of different applications.

**S11.002**

### Consumer Innovativeness and the Acceptance of Fruit Innovations: Which Characteristics make New Fruit Products Appeal to the Consumer?

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Despite constant developments in the area of product and marketing innovations, most of the new products in food and drink industry fail (Martinez and Briz, 2001). Some authors estimate the success rate even as low as 10-15 % (Cooper, 2001; Martinez and Briz, 2001; Van Trijp and Steenkamp, 2005). The aim of this study was to increase insight in consumers’ willingness to adopt novel fresh fruits and fruit products. A consumer survey (n=1972) was conducted in The Netherlands, Greece, Spain and Poland on the following topics: 1) Consumer perception of important product characteristics of novel fresh fruits and fruit products, 2)

Product evaluations of novel fresh fruits and fruit products and 3) Buying intentions and actual buying behaviour. Tastiness and Healthiness were the two most important product characteristics for buying intentions on new fruits and fruit products, followed by Reasonably Priced and Safe. The perceived importance of product characteristics differed to a small extent between fresh fruits and fruit products. The differences in perceived relevance between the different countries were bigger. In general the Polish respondents seemed to be the most innovative, while the Dutch respondents were the most conservative. Based on the results of the survey, different Product Market Combinations (PMCs) for the different countries were presented.

**S11.003**

### Investigating the Effects of Marketing Communication on the Adoption of Innovative Fruit Products: A Choice Experiment

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To effectively market innovative food products it is important to understand what makes innovative products attractive to consumers. In the present study, a choice experiment was conducted to investigate the effectiveness of five marketing claims in the context of innovative fresh fruits and fruit products. In total, 407 Dutch adults completed an on-line questionnaire containing the choice experiment. Two novel fresh fruits and two novel processed fruit products were chosen as target products. Participants were asked to choose eight times between two fruit products (e.g., Apple 1 versus Apple 2). These two products differed in five marketing claims: (1) social information, (2) scientific information, (3) technology versus naturalness, (4) expiry date and (5) price. All five marketing claims had a significant effect on product choice. The most important factors were price and naturalness. It can be concluded that claims stressing a natural product and a low price can be used to effectively market innovative fruit and fruit products.

**S11.004**

### Development of a New Fruit Snack with Nutritional Potential - Interdisciplinary Approach Considering Consumers’ Preferences and Process Impact

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Regular consumption of fresh or processed fruits may prevent cardiovascular diseases, diabetes and some cancers, particularly thanks to antioxidant micronutrients naturally present in fruit. In this study, attractive fruit snacks were developed in order to meet consumers demand for healthy and convenient foods. An iterative approach was proposed, combining, in different steps, technological research with results from sensory and consumer research. Drying of fruits was investigated to design new products, and conditions were optimised to improve sensory quality and dietary value. Soaking was applied as a pre-treatment as it offers opportunities to enhance the sensory quality and fortify fruit tissues with health-promoting compounds. Fruits were then either freeze-dried or air-dried. The evolution of native polyphenols during dehydration as well as the enrichment in functional ingredients has been studied, as the impact of different osmotic agents on the sensory perception and acceptability of dehydrated fruit. The osmotic solution significantly influenced taste and texture profiles of the dehydrated fruit, and affected their sensory acceptability, but the effect depended of the different species and drying method. In parallel, consumer insights were gathered. Consumers’ expectations for dried fruit were studied in a large scale consumer survey, in Poland, The Netherlands and France.

Cross cultural segments based on high and low health conscious consumers were used to create groups of consumers. Those groups differently perceived the healthiness and convenience of the products. After that, intentional and actual consumer behaviours were compared on the basis of a sensory test on optimised osmo-dried cherries and blackcurrants. In addition novel fruit crunchy snack bars with osmo-freeze-dried sour cherries and apples were also designed and tested by consumers. Results show that this interdisciplinary approach resulted in technical possibilities to provide new, high nutritious fruit products for European consumers, through integrated use of combined technologies with sensory and consumer research.

### S11.005

#### Consumers' Willingness to Pay for Reduced Pesticides Use on Production of Fresh and Processed Apples

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Nowadays, consumers are becoming more aware of pesticide risk problems. Changes are recorded in consumer behaviour because of food safety or of environmental ("sustainability") considerations, or both. The individual consumer faces a trade-off between the utility derived from tastes and characteristics of a product, the utility of behaving "green" and the utility of healthy dieting. In this work, we used experimental markets to measure the consumers' willingness to pay (WTP) for apples and apple juice produced with reduced pesticide use. In order to see the impact of different information about pesticides use, different apple types were used which are products with different levels of pesticides: Regular apples, Integrated Pest Management (IPM) apples, Organic apples. To know if the potential diversity in consumer behaviour was depending on geographical location, experimental participants were randomly recruited from the general population in Portugal and France. Here, the protocol's experimental design was applied to 207 consumers of apples and apple juice. Two different auctions mechanisms were compared: one direct method (direct sales with different prices with the Becker-DeGroot-Marschak) procedure and an indirect method (choices between different size lots of apples). We show that there is a consumer WTP for pesticides use reduction (a premium for product with specific signal) and that specific information on pesticide use increases this WTP for organic product but not for IPM products. However, the most important result is that the specific information decreases the WTP for the regular product. Then it seems more rigorous to treat the results in terms of a "premium against the regular product", anticipating the loss of market share for the regular product. After showing that consumers' premium for pesticide reduction is not independent from the product's sensory attributes, we give the quantitative results for the consumers WTP for a pesticide reduction.

### S11.006

#### Introducing New Apple Cultivars through a Coordinated Approach from Consumer till Breeder

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The introduction of new apple cultivars into a worldwide full market can only be successful if all parties of the complete production-market chain cooperate closely together according to a mutually accepted strategic plan. In 2001 such a strategy was developed by Inova Fruit BV in close cooperation with Applied Plant Research (PPO), fruit extension specialists, and the Dutch Fruit Growers Organization. Consumer preference was the starting point for selecting new cultivars from the hundreds of cultivars tested by PPO during the last decades. With the consumer preferences in mind, cultivar profiles were developed listing the traits desired by nurseries, growers and sales organizations. To remain successful in the market both production and quality of the apples should be under strict control to continually

meet the consumer demands. This also creates the best guarantee for good prices for the growers. To achieve these objectives the selected cultivars were introduced as 'club varieties'. This implies the use of specific brand names, controlling numbers of trees produced and planted, and organizing the sales and marketing of the apples. Initially, four apple cultivars were selected matching the preferences of different groups of consumers. These cultivars were introduced to the growers. In 2003 pilot-orchards were established in the Netherlands and Belgium. These pilot-orchards served to develop the guidelines for cultivar-specific cultivation protocols. Further, these pilot-orchards were used to optimize cultivation practices and post harvest storage conditions. In 2004, four cultivars were released and given the brand names Junami<sup>®</sup>, Rubens<sup>®</sup>, Autento<sup>®</sup> and Wellant<sup>®</sup>. The first commercial orchards were planted in 2005. Autento<sup>®</sup> was withdrawn in 2006. Up to 2010 about 1,43 million Junami<sup>®</sup>, 600,000 Rubens<sup>®</sup>, and almost 350,000 Wellant<sup>®</sup> trees have been planted. Cultivar specific marketing and promotion campaigns have been carried out and contributed significantly to the success of these new cultivars within Europe.

### S11.007

#### Modification of Date Fruits According to Consumer Preferences in Iran?

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Date fruit as one of the most important nutrient is well known through the world, but total global demand for fresh consumption has not been more than 8.86 per cent of annual fruit production during last 20 years. According to FAO statistics reports in 2009, Iran as the second major dates producer country, exported 12.30 per cent of its fresh fruits production on average over the same period. Daily consumption of 24 g fresh dates in Iran showed that around 30 per cent of date's annual productions (315000 tons) were surplus, approximately. Therefore, it can be logically concluded that consumer preferences have to vary and extent. More than 50 natural and industrial byproducts can be basically produced from different parts of date palm; nevertheless most of them have traditionally produced such as Syrup, honey, liquid sugar, and paste since centuries in Iran. Moreover, studies have showed that production of vinegar, alcohol, caramel, chocolate, pickle, salty mixture, souse, and coca-like drink have extended between date producers. Fortunately, some of date byproducts such as alcohol and syrup are industrially produced since recent decade in Iran, but insufficient use of low quality cultivars, traditional methods of byproducts' production, lack of national standards, and shortage in modern packaging technology are the main obstacles by this time.

### S11.008

#### Consumer Fruit Preferences and Consumption Behaviour

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Policy making is underpinned by scientific expertise, ensuring that the decisions reached are reasonable, justifiable and effective, and to provide accountability and value-for-money; possibly also facilitating greater public acceptance, and thus a valuable tool in policy-makers' efforts to manage accountability and justify value-based decisions. The way in which in scientific research finds its way into policy documents to provide recommendations for professionals and guidance for practice is important, but often opaque. The preferred approach to producing guidelines is through consensus amongst stakeholders around the available evidence. The adoption of consumer behaviours in line with recommendations is of course not guaranteed. The Social Ecological Framework offers a means for understanding the levels through which people's behaviour can be influenced and the following levels can be distinguished:  $\lambda$  intrapersonal (e.g. an individual's knowledge, skills, attitudes, values, preferences, emotions, values, behaviour),  $\lambda$  interpersonal (e.g. an individual's social networks, social supports, families, peers, and neighbours)  $\lambda$  community (e.g. community resources, neighbourhood organisations, social and health services),  $\lambda$  organizational (e.g. businesses, public agencies, churches, service organisa-

tions), and  $\lambda$  public policy levels (e.g. legislation, policies, taxes, and regulatory agencies, health system, social care system, political/geographic environment). This framework will be used to consider the relationships between the factors influencing fruit consumption, a behaviour considered core to achieving a healthy diet. The behavioural mechanisms facilitating and mitigating against changes in fruit intake will be explored to identify optimal policies and strategies for encouraging fruit consumption in the context of healthy, safe and sustainable diets.

## S11.009

### Promoting Fruit Consumption in Europe: A Segmentation Study Based on Consumers' Evaluation of Product Benefits

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Despite promotion efforts, only a few countries are currently meeting the recommendation of fresh fruit on a population level (Groot *et al.*, 2007). Furthermore, differences in average fruit consumption can be noticed across European countries (Naska *et al.* 2000) as well as within countries (Briz *et al.* 2008; Kamphuis *et al.*, 2006; Pollard *et al.*, 2001, 2002). These studies show minor attention to the background of this consumption behaviour in terms of consumers' evaluation of the perceived benefits of fruit products, the role of consumption moments and personal orientations. In developing new types of fruits and fruit products as well as to encourage fruit consumption through well-planned interventions, segmentation of European consumers is needed. The aim of this study is to explain attitudes and preferences for different fruits and choice behaviour with respect to different fruits from consumer orientations and analyse the role of benefits to develop a cross-cultural benefit segmentation of consumers for fruit. A large-scale consumer survey was conducted among 2083 European consumers across Greece, Poland, Spain, and The Netherlands in 2008, as part of the ISAFRUIT project. The results show that five interesting European segments can be identified. Segment 1 (27%) is indifferent and average to all benefits (evaluation of beliefs and feelings). Important benefits for segment 2 (12%) are related to safety and health. Segment 3 (9%) is looking for quick and easy satiety; all benefits related to convenience are important and largely influenced by the out-of-home situations. In segment 4 (7%) the European consumers perceive food as a necessity; they are pragmatic and perceive all affective benefits relatively unimportant. Segment 5 (4%) are mainly women and the benefits are extremely related to health and feelings. All segments are profiled as a fundamental basis for effective marketing strategies in order to stimulate European fruit consumption.

## S11.010

### "This Is Free. Great. I'll Eat More of It!.." Exploring the Dynamics of a Workplace Intervention (The Fruit at Work Study)

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The workplace has been identified as an ideal setting for health interventions, however few UK based workplace intervention studies have been published. Fewer still focus on the practicalities and implications when running an intervention within the workplace setting. In an office-based workplace intervention (the Fruit at Work Study), 409 participants were randomly assigned by floor to receive either daily access to free fruit (intervention group) or no fruit (control group) for 18 weeks in a quantitative cluster randomised controlled trial. Recorded interviews were conducted with the intervention group, transcribed verbatim and verified. The data were imported into Nvivo 7 with analysis guided by Grounded Theory research

and the data subjected to content analysis. The transcripts were read repeatedly and cross-compared to develop a coding framework and derive dominant themes. Twenty-three in-depth and open-ended interviews were conducted around the interim (week 9) and final measurements (week 18) to describe what was occurring behind the scenes of this workplace intervention. The interviews explored issues around fruit intake and other health behaviours both inside and outside of the workplace. The analysis revealed the individual's motivations for taking part in the study, their aspirations and expectations of the study and offered insight regarding their perceptions of the availability of free fruit in the workplace on their diet and food behaviours. The interviews suggested the importance of the peer effect and the workplace environment in encouraging and supporting healthy behaviours. Using a qualitative method to complement a largely quantitative study added breadth and depth to the findings. It offers insight into the dynamics and interactions occurring behind the scenes in a workplace intervention. The findings will be useful in the future design and development of workplace and dietary interventions.

## S11.011

### Scientific Based Approach to Promote Fruit and Vegetable Consumption in Spain

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The consumption of fruits and vegetables have been considered traditionally by Spanish society as a good habit to promote human health, although this pattern is changing in the last years due to economical, demographic, social and cultural influences. Fruit and vegetables consumption was increased during the last year, 5% in fresh fruits, 95.3 kg/per capita whereas the vegetables increased 3.8%, 82.10 kg/per capita being tomatoes, potatoes and salads the most important. Scientifics and Officials statements have been working together in order to promote the adequate consumption of fruit and vegetable. Fundación Sabor y Salud was created in 1999, with the main goal to promote the studies on the advantages and health benefits of fruit and vegetable consumption and its communication to general public. These actions were according to those established by the European Community, such as the intervention determinate in the (CE) No 13/2009 regulations. Research indicates Spanish children generally have a low level of consumption of fruit and vegetables. This is an initiative to encourage children to eat more fruit and adopt healthier lifestyles in schools, and it is aims to provide a jump-start to healthy eating and lifestyle choices for Spanish public in general and children in particular. The project has two parts well defined, first is targeted to link consumers and fruit science and the second is focuses on the efforts to encourage and support activities in schools or sport events to increase healthy eating and physical activity, with special incidence on fruit consumption. The link between consumers and fruit science is addressed by a web page ([www.fundacionsaborysalud.com](http://www.fundacionsaborysalud.com)) that includes information about news, latest releases, scientific events, fruit regulation, official nutritional recommendation and others.

## S11.012

### Exploration of Consumers' Health and Fruit Perception of West Balkan Countries

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Perception and consumption of fruit is often studied from a western European perspective. The aim of this study is to explore motivations and barriers of fruit

and fruit products consumption from Western Balkan perspective. Six different countries are covered in the Western Balkan Region; Bosnia-Herzegovina, Croatia, FYRoM, Montenegro, Serbia and Slovenia. By means of 30 in-depth face to face interviews in each country a qualitative understanding of healthy life, well balanced diet, consumption of fruit, motivations and barriers of fruit consumption, association with fruit and non fruit eaters and knowledge about nutritional value of fruit in the WBC is gained. In accordance with literature taste and health are mentioned as the most important motivations to eat fruit. It is striking that convenience aspects and appearance seem not to motives which are taken into consideration in this region. The most often mentioned barriers related to fruit consumption are lack of habit, price and availability. Especially with regard to lack of habit some intriguing aspects are mentioned; i.e. fruit availability in childhood and fruit is mainly consumed at home. The image of a fruit eater is a good looking slim woman who is active and successful, while the non fruit eater is an overweight man less active and slow. While in EU countries it seems that people have difficulties with personalizing themselves with a non fruit eater. It seems that in some of the WB countries the participants feel less hesitation to compare themselves with the non fruit eater. Generally spoken the participants of all six countries mention the same motivations and barriers and mention the same aspects with regard to health perception. Nevertheless, there seem to be some differences between man and woman, and rural and urban population. Whereas the rural participants prefer the home grown and self prepared fruit better.

### S11.013

#### Increasing the Consumption of Fruit: Sensory and Consumer Approaches Provide a Focus for Research on Improving Eating Quality

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Increasing fruit consumption is important for maintaining and improving the health of human populations as well as having a positive effect on the economic sustainability of industries. For the past decade our research has focussed on ways to integrate sensory and consumer approaches into research on the biology of perennial fruit crops. The aim has been to link understanding of consumer preference and choice of fruit directly into research programmes focussing on the genetic and environmental factors that influence fruit quality. There are generally four reasons for undertaking these studies: (1) the need to develop quality control instruments, (2) the desire to predict consumer responses to novel fruit and/or higher quality offerings of existing fruit, (3) the desire to understand what is being perceived in human sensory assessments of fruit, and (4) the need to fundamentally understand the biological processes that determine eating quality of fruit. In this presentation, we will show that biological processes associated with the transport and accumulation of carbohydrate from the tree or vine into fruit have a fundamental role in determining consumer acceptability of kiwifruit, stonefruit, avocados and apples. For apples, we will provide evidence for a new index that can be used to predict overall consumer acceptability of fruit harvested from an orchard. We propose that the ability to directly link physiological processes that occur within fruit to consumer preferences may provide a more direct way to understand and establish targets for improved eating quality via manipulation of tree or vine management practices as well as manipulation of genetic and environmental factors. These targets need to be integrated into a broader knowledge of non-sensory as well as sensory factors that determine how well fruit meets the needs of consumers' lifestyles.

### S11.014

#### Quality Attributes of Preferred Apple Varieties for Each Consumer Segment in Europe

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A European consumer test of new varieties was developed in 17 different cities across 7 European countries (France, Germany, Italy, Netherlands, Poland, Switzerland and Spain). A total of eleven varieties, including most common apple varieties (Golden, Jonagold and Fuji) as well recently introduced new varieties (Cripps Pink cov, Ariane cov, Civni cov, Nicoter cov, Milwa cov, CPRO47, Ligo!, Goldpink cov) were considered in the consumer test with the initial hypothesis being that new better quality varieties could help in increase fruit consumption. The consumer test consisted basically of a flavor acceptance test using a 9 point hedonic scale. Approximately 4500 consumers took part in the test during the months of January and February of 2007. Data from a hedonic sensory test and from a trained panel test were combined in a preference analysis map. Results identified 6 population segments and their associated preferred varieties. Each consumer segment differed in the characteristics of the most accepted varieties. Results on models to predict the acceptance scores for each consumer segment as a function of instrumental quality attributes (Soluble Solids Content, Total Titratable Acidity and Firmness) and sensorial attributes (flavor, texture and aroma) will be presented based on the preference map analysis.

### S11.015

#### Preference and Ideal Pear Appearance among European Consumers Using Colour Images

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The pear industry in South Africa exports more than one third of their total crop. From this amount more than 80% is exported to the European Union and the United Kingdom. Therefore, it is important to understand the needs of these consumers in order to stay competitive on overseas markets. Photographs of different pear cultivars of varying colours and shapes were shown to 60 pear consumers currently living in or originally from a European country. Ten European countries were represented but these were divided into two categories, namely Great Britain and continental Europe. The degree of liking of colour and overall appearance and their willingness to pay for the pears was asked as well as general questions regarding their ideal pear. Preference was for the green, yellow and light blush colours for both groups, although Great Britain generally awarded higher values. The same results were seen for the degree of liking of overall appearance with only pears that had a round or elongate shape decreasing in preference. There was a strong positive correlation between the colour liking and the overall appearance. There was also a strong positive correlation between the willingness to pay and degree of liking of colour as well as with the degree of liking of appearance. In conclusion, the European market is looking for a bright yellow, green or light blush, pyriform or 'pear shaped' pear.

### S11.016

#### A Consumer-Oriented Approach for Breeding New Apples

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The introduction of new cultivars on the market is vital for fruit industry to get better products and to attract consumers with innovative fruit types. However, in an extremely competitive market as the present, is becoming always more uncertain and expensive the path from field selection to commercial production. Further-

more, market has a tendency to split into two classes of produce: high-quality and commodity (low price) and new cultivars should aim to reach the highest level. Apple cultivars can provide a wide range of variation in sensory quality which, a correct information, can convert in drivers for sustaining apple consumption through an increased consumer satisfaction. A breeding approach focused on consumer-oriented quality offers tools able to be responsive to the marketplace changes. A comprehensive sensory evaluation should include a trained panel providing accuracy, sensibility and repeatability of judgement, integrated by hedonic tests. Collaboration between CIV and IBIMET-CNR has approached sensory and hedonic evaluation of new and standard apple cultivars by an integrated approach, including lab, panel and consumer test. Definition of sensory profile and evaluation of consumer acceptance are also helpful in orienting marketing strategies. Before market debut the cultivar Mod<sup>®</sup> (CIVG 198) was submitted to sensory and hedonic tests, resulting useful for marketing, advertising and consumer information. Studies on consumer-perceived quality of CIV selections will be presented and discussed as related to decision making from breeding to marketing.

### S11.017

#### 'RS103-130' Scab-Resistant Apple - From Orchard to Consumer

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'RS103-130' is a new scab-resistant apple developed by Agri-Science Queensland. Fruit mature six to eight weeks after 'Gala', and have a broken red stripe to almost full block red overcolour on a yellow-green background. This paper reports on the yield and quality of 'RS103-130' apples produced from high density systems planted at Applethorpe Research Station (28o 37'S) in southern Queensland, and on evaluations of 'RS103-130' appearance and eating quality by consumers in Brisbane, Australia. 'RS103-130' trees on M.9, MM.102, Ottawa 3, M.26 and MM.106 rootstocks were planted in 2004 at a density of 2500 trees/ha and trained to a 6-wire vertical trellis. A double-row open V-trellis system (M.26 and MM.106 rootstocks) at densities of 3555, 4444 and 5925 trees/ha was also planted. Annual yields of up to 60 - 70 tonnes/ha have been achieved from trees in their fifth and sixth leaf, with packouts to 90%. No sprays for apple scab control (except for green tip copper) have been applied since planting, and 'RS103-130' continues to show no incidence of leaf or fruit symptoms of apple scab. Consumer evaluations of 'RS103-130' apples were undertaken in May 2009 (two months after harvest) and December 2009 (nine months after harvest). Commercial varieties included as comparators were 'Fuji', 'Pink Lady' TM and 'Jonagold' in May 2009, and 'Royal Gala', 'Hi Early Red Delicious' and 'Sundowner' TM in December 2009. 'RS103-130' was rated highly by consumers on both occasions, and in May 2009 scored as most preferred or equally most preferred apple for appearance, flavour and texture. Instrumental measurements of postharvest quality to evaluate the rate of flesh browning after cutting, and the rate of softening when stored at room temperature (20°C) over four weeks, showed 'RS103-130' to be equal to or superior to the commercial apple varieties in retaining texture and firmness, and resisting flesh browning.

### S11.018

#### Nutrition and Health Claim Possibilities Food Processed Fruit

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In order to bear nutrition or health claims a food needs to comply with the rules set out in the European "claims regulation" which came into force in July 2007 (1924/2006/EC). Nutrition claims on processed fruits and berries can be made for energy, fat, protein, fibre, salt, sugar, minerals and vitamins. For claims on antioxidants or on other substances the claim needs to be scientifically substantiated. The European Food Safety Authority (EFSA) has taken the view that protection of

DNA, proteins and lipids from oxidative damage is beneficial to human health. For the well known nutrients, such as vitamin C and E, selenium and manganese the antioxidant health claim is based on generally accepted science and the cause and effect relationship has been established between the dietary intake of the nutrient and the protection of DNA, proteins and lipids from oxidative damage. Antioxidant health claims are thus a possibility for many processed fruit and berry products. Regarding other substances in fruits and berries, such as carotenoids and phenolic constituents, data generally exist showing antioxidant properties or other bioactivities *in vitro*. However, the human studies available provide limited or no evidence in support of an *in vivo* effect. In most cases there are only a very few studies, if any, that have been carried out using relevant markers regarding disease risk. Substantiation of a health claim on processed fruits and berries may also be impossible for the reason that the product or rather the substance responsible for the claimed health effect has not been well characterized and thus cannot be verified by authorities by well established methods. For example, polyphenols are a too wide and heterogeneous group to provide sufficient characterization while cocoa flavanols, bilberry anthocyanins, or cranberry procyanidins are sufficiently characterized.

### S11.019

#### Fruit Consumption and Obesity

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Fruit and vegetable consumption across most developed countries currently falls below recommended levels despite some success from health promotion programmes and a strong public awareness of the recommendations for dietary fruit and vegetable intake. These recommendations focus on the total intake of fruit and vegetables; likewise many studies fruits and vegetables are considered a single entity. Where data are separated in observational studies, fruit intake is often shown to be inversely associated with obesity measures such as BMI, waist circumference and abdominal adiposity (i.e. higher fruit intake correlates with lower measures), and other risk factors for cardiovascular health. However, there is limited evidence to confirm a causal relationship for these observations. In general, dietary recommendations aimed at reducing overweight and obesity include increased consumption of fruit and vegetables as a goal; the aim being to eat a diet which is rich in high-fibre, low-energy-dense foods. Consumption of these foods may cause early satiation and prolonged feelings of satiety due to increased gut fill and changes in digesta passage through the gut. We know little about the effect of different types and amounts of fruit (and vegetables) on these factors, nor the effects of other fruit constituents/nutrients on metabolic processes. There is increasing interest on the effects of antioxidant compounds in fruit on inflammatory status and lipid metabolism as possible mechanisms through which increased fruit consumption may be beneficial. This paper will review evidence for the benefits of increased fruit consumption on obesity measures and explore some of the possible modes of action.

### S11.020

#### The Role of Fruit in the Prevention of Overweight and Obesity

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The global obesity epidemic is associated with a sedentary lifestyle and diets rich in high-fat, and high-energy foods. The potential role of fruit in preventing overweight and obesity is related to their low energy density, high content of dietary fibre, and associated increasing satiety effects. The physical disruption of fruit is of considerable importance for satiety, as shown in studies where fruit juices were less satisfying compared to sugar-equivalent intakes of purées and whole fruits. The potential role of fruit in the prevention of overweight and obesity may be connected to the dietary pattern of fruit intake and with the possibility that fruit intake may substitute for other more energy dense foods. According to a recent review, the majority of human prospective cohort-, intervention-, and cross-sectional studies in adults suggest a preventive effect of relatively high fruit intake on overweight and obesity. A few studies have suggested the opposite in the case of fruit juices.

In behavioural intervention studies, participants are often advised to undergo several changes towards a healthy diet and lifestyle, making it impossible to quantify the specific role of fruit intake on body weight. Findings from the few available controlled clinical trials, where participants are either overweight or obese at the beginning of the study and subjected to strict dietary regimens cannot be applied directly to free-living individuals of normal weight. However, preliminary results from a newly finalized ISAFRUIT workplace intervention study among free-living normal weight individuals indicate that high availability and accessibility of fruit have a positive impact on the participants' BMI (body mass index). The results from the ISAFRUIT study thus strengthen the evidence that fruit has a role in the prevention of overweight and obesity.

### S11.021

#### Apples and Processed Apple Products Affect Blood Lipids Differently in Healthy Volunteers

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Apples are rich in polyphenols and dietary fibre, however it is not clear which apple components are responsible for the reported beneficial effects on health. To try to clarify this, we conducted a randomised, single blinded crossover study in 24 healthy volunteers. They supplemented a polyphenol and pectin restricted diet with whole apples, apple pomace, cloudy or clear apple juices or nothing for 4 weeks. The clear juice was pectinase treated and filtered to remove pectin and solid cell wall components. Each period was separated by 2 weeks washout periods. Blood, urine and faecal samples were collected at the beginning and end of each intervention period. Results from the present study suggest that pectin or other cell wall components are necessary for the observed beneficial effect on serum cholesterol concentrations. The whole apple had the strongest hypocholesterolemic effect, followed by apple pomace and cloudy apple juice. The clear apple juice, which is free of cell wall components showed adverse effect on serum cholesterol concentration and the effect differed markedly compared to the other apple products. There was no effect on HDL-cholesterol, triacylglycerol, weight, waist-to-hip circumference or blood pressure. We conclude that the cholesterol-lowering effect of apples is most likely due to the content of soluble fibre or other cell wall components. We are presently investigating whether this is explained by increased faecal excretion of bile acids.

### S11.022

#### Effects of Whole Apple and Apple Products on Markers of Colon Carcinogenesis

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Regular consumption of fruits and vegetables is associated with reduced risks of certain cancers, cardiovascular diseases, stroke, Alzheimer disease etc. In this presentation, the focus is on apples, which are the most highly consumed fruits in northern parts of Europe. We have investigated whether whole raw apple or apple products derived here from; purée, pomace, clear/cloudy juice and pectin might possess chemo-preventive properties against colorectal cancer risk markers in the rat. The histological biomarker, the aberrant crypt focus, was chosen as the marker for colon carcinogenesis. Weanling rats initiated by a single dose of 1,2-dimethylhydrazine dihydrochloride (DMH), a known artificial colon carcinogen given orally four times at weekly intervals received daily 5 or 10 g fresh apple or apple products for 13 weeks. The rats were kept on purified diets, which were adjusted with regards to micro- and macronutrients in order to focus on the possible anti-carcinogenic effects of non-nutritive compounds and apple fiber. To further evaluate potential chemopreventive effects of raw apples, comet assay was performed on

leucocytes, liver and colon epithelial cells to evaluate the antigenotoxic potential. The transit time was measured as well. We showed that feeding of 5 g whole fresh apple per day to rats significantly lowered the number of colon aberrant crypt foci but this effect was not observed at the high apple dose when compared to controls. Data on comet assay and transit time were not significantly affected but tended to support a cancer protective effect of whole apples. It seems that whole raw apple had a more marked effect on markers on colon carcinogenesis than apple products derived from the same apple batch.

### S11.023

#### Health Effects of Apple Products – Can They Match the Fresh Apple?

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Apples are among the most highly consumed fruits in Europe and world-wide and there is good evidence that consumption of apples per se has beneficial effects on health. Several constituents might be responsible, including insoluble and soluble fibres, polyphenols, sterols, and other components. These constituents are sometimes lost or even deliberately removed during processing, so apple products may partially or wholly lose their effects on health. We have used several profiling techniques in a series of rat and human studies with well-characterized apples and apple products in order to investigate the relationship between whole apples, apple processing, and potential health effects. Using array technology we have identified several biological pathways that are affected in rat liver and colon following apple feeding. Using markers for these pathways we found that some effects are lost during apple processing while others are retained specifically in juices, pomaces or pectin fractions. Among the pathways affected are pathways related to the interaction between the gut microbiota and the host. By using a combination of DGGE and metabolomics we have identified some of the bacterial strains affected by specific apple constituents and some of the compounds responsible. Other pathways affected involve cholesterol metabolism and might explain the effects of apples on cholesterol. Again the effect is highly dependent on the apple processing with some fractions being more active than others. This presentation will give an overview of the research outcomes while specific parts of it will be detailed in other presentations.

### S11.024

#### Fruit Allergens: Their Structural Characteristics Relevant for Diagnosis and Preventions Strategies

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Upon frequent contact with allergen sources predisposed individuals develop IgE mediated allergic reactions ranging from mild local reactions to life threatening generalised symptoms. In the past decade the number of identified food allergens has tremendously increased including plant derived proteins. Nevertheless, these proteins can be assigned to only a limited number of protein families with certain biological functions such as hydrolysis of proteins/polysaccharides, binding, transport and storage of ligands and cytoskeleton association. In depth knowledge about the 3D structures of individual food allergens, their biological activity and stability will help to fine-tune diagnosis of food allergy and assess the risk of cross reactive allergies to other food sources. This is especially important for fruit allergies where unnecessary exclusion diets could lead to vitamin deficiencies. Furthermore, some

allergens, such as the non-specific lipid transfer proteins (ns-LTP) are known to induce severe allergic symptoms while others (pathogenesis-related proteins group 10; PR10) tend to evoke mild local reactions. This has been shown for individual allergens from apple and peach. Apart from the intrinsic features of food allergens different food matrices may impact on these proteins and either up- or down-regulate their allergenic activity. For example different pH conditions affected the stability of allergens from the PR10 family and the LTP family. Finally, the allergenic repertoire of fruit species and their cultivars may quite markedly differ. For example for the abundance of actinidin, the major kiwi allergen, there is a hundred fold difference between the green and gold kiwi species. In conclusion, all these physicochemical data about food allergens will not only affect patient tailored diagnosis of fruit allergy, it will also contribute to improve food processing strategies. This in turn will facilitate to reduce the risk of allergen exposure and to hand over high quality information to the allergic patient at risk.

### S11.025

#### Which Genes Are Involved in Apple-Allergenicity? A QTL Mapping Approach

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Apples are generally considered to be a healthy component of the human diet. However, 2%-4% of the NW European population is allergic to apple, suffering from the Oral Allergy Syndrome. Three allergens can be involved: Mal-d-1, Mal-d-2 and Mal-d-4 of which Mal-d-1 is generally considered to be the most important. Apple cultivars are known to differ in allergenicity, but knowledge of the genes involved is lacking. This knowledge is crucial for increasing availability of hypo-allergenic apples through appropriate cultivation and the breeding of new cultivars. To date, 28 putative major allergen loci have been identified and mapped on the apple genome. To improve our understanding of the genes involved, we performed a QTL mapping study in which Skin Prik Test (SPT) responses of an apple allergic individual were associated with the genetic composition of the tested apple genotypes. Co-localization of a QTL with an allergen gene indicates involvement of this gene, whereas non co-localization indicates a role for regulating genes or metabolites that enforce allergy responses. Twenty four individuals were tested with 87 apple progenies of the crosses "Prima x Fiesta". The area of the wheals obtained was used as a measure for sensitization. Areas were expressed relative to the SPT of histamine, 10log transformed, and analyzed using 1) Map QTLTM and 2) Fishers exact test for differences in marker frequency between progeny subgroups that show quite different SPT results. Only a few individuals gave QTL that co-localize with Mal-d-1 genes, whereas several individuals showed co-localizations with Mal-d-2 and Mal-d-4 genes. Mal-d-2 genes showed complementary action with additional loci, which may indicate the need for some specific modifications (binding to specific sugars?). One QTL co-localized with a metabolite (locus) that mediates inflammation responses. These results suggest a need to re-evaluate the widely assumed dominant role of Mal-d-1 in apple allergy.

### S11.026

#### Allergenicity of Apple Cultivars as Assessed by Prick-to-Prick Skin Prick Tests and Single Blind Oral Food Challenge Tests

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Background: As apple is a frequently consumed fruit in North West Europe and oral allergy symptoms (OAS) to apple are frequent (2-4% prevalence), the avail-

ability of hypoallergenic apples is desirable. Aim: To evaluate the allergenicity of 75 apple cultivars in a large adult study population with (OAS). Method: In the first year, 75 apple cultivars were tested by prick-to-prick skin prick tests (SPTs) in 33 Dutch adult patients with OAS, before and during the birch pollen season (fall 2006 and March 2007 respectively). In year 2, three cultivars yielding the largest number of negative SPT responses (Elise, Santana or Modi and Pink Lady) and one highly allergenic variety (Golden Delicious) were tested by single blind oral challenge tests in Dutch adults with OAS in the fall of 2007 (31 patients) and the spring of 2008 (32 patients) before the birch pollen season, preceded by SPTs. Subjective symptoms were scored on a Visual Analogue Scale (VAS). Results: In the fall of 2007, VAS scores of Elise were significantly lower than those of Santana, Pink Lady and Golden Delicious ( $p = 0.021$ ;  $0.040$  and  $0.005$  respectively (Wilcoxon Signed Rank test). VAS scores of Santana were significantly lower than those of Golden Delicious ( $p = 0.049$ ). In the spring of 2008, VAS scores of Elise were significantly lower than Golden Delicious ( $p = 0.038$ ). Within each apple cultivar, there were no significant differences in VAS scores between the two test series, except for Golden Delicious (spring < fall:  $p = 0.021$ ). The SPTs did not predict the severity of OAS as measured by VAS scores. Conclusion: Elise significantly elicited less allergic symptoms than Pink Lady, Modi and Golden Delicious. The prevalence and severity of OAS cannot be predicted by SPTs. Seven months of storage did not affect the allergenicity of the apples significantly.

### S11.027

#### Communication Strategy to Safely Increase Fruit Intake among Fruit Allergy Sufferers

**Andersen, M. S.; Hall, S.; Vlieg-Boerstra, B. J.; Dragsted, L. O.**

About 4% of the European population are allergic to one or more fruits. For these people, fruit allergy is a barrier to achieving their 5 a day intake as part of a healthy diet, as they tend to avoid the fruits that cause development of allergic symptoms. Fruit allergy is a complex disease with symptom development and involved fruits varying highly between individuals and a not fully understood aetiology. One of the major obstacles for diagnosing fruit allergy and prescribing optimal avoidance diets are incomplete immunologic tests, as it is not possible to identify exactly which compounds and concentrations trigger development of an immunologic reaction. In order to increase availability of safe fruit for fruit allergy sufferers, one strategy adopted in ISAFRUIT has been to create an information portal on the internet called 'Fruit and Allergy'. The portal is based on a division of fruit allergy sufferers into four characteristic types. These four types have been developed by reviewing existing published data from which the outcome of immunological tests have been associated to the symptomatic picture, concomitant pollen allergies and geographic location. By taking an online questionnaire, fruit allergy sufferers are allocated to their most likely type of fruit allergy and thereby can directly access information that is relevant for them about low-allergenic fruit varieties and directions about how to prepare and grow fruits in an allergy-friendly way. The 'Fruit and Allergy' portal provides fruit allergy sufferers with the latest research developments and furthermore provides an opportunity for consumers to contribute to future research and to question the researchers in ISAFRUIT via a forum or via email.

### S11.028

#### Genomic Organization of the Mal d 1 Gene Cluster on LG16 of Apple

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Apple allergenicity is an important issue for a growing number of European citizens. Among the main four apple allergens, Mal d 1 is classified as a complex gene family with at least 18 loci of which 8 are clustered on linkage group (LG16). To effectively study the contribution of individual Mal d 1 genes to allergenicity through association and expression studies, all Mal d 1 genes should be known.

In this work we aimed to clarify the number and sequence identity of the Mal d 1 genes of LG16 through the sequencing of Mal d 1 containing BACs. Hereto a BAC library of Florina was screened for clones that contain Mal d 1 genes. Two clones located on LG16 were selected and full-length sequenced. As a result, a total of eleven Mal d 1 genes were found, of which one was completely new, and three were known but not yet mapped. Also information was gained on gene orientation and physical distances. The anchoring of the physical and the genetic map of this region has been successfully achieved. Finally, many retrotransposons elements were found in the Mal d 1 region on LG16. These results increased our understanding on Mal d 1 gene duplication and evolution.

### S11.029

#### Decision Support in Sustainable Farm and Supply Chain Quality Management

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To assure that our fruits reach the consumer in an optimum state for consumption it will be necessary to be able to position the fruits in the retail shelves exactly within the desired window of maturity. The biological variation in quality and maturity, inevitable during growth has to be included in the assessment of usefulness. New non-destructive techniques to determine maturity at harvest and during postharvest life and the assessment of the biological variation within a batch of fruits, allow us to control the logistics and postharvest conditions in such a way that it enables us to assure optimum quality for the consumer for each batch separately. Although this has only been done on a semi-practical level for a few fruit species as yet, it makes clear that the future of 'Quality Controlled Logistics' is near. When these techniques become common practice, we can assure that consumers will be offered fruits of high quality all the time. As a consequence of this it is to be expected that fruit consumption will rise (or at least remain stable) and that the competition in the market and the supply chain will shift from price based to quality based.

### S11.030

#### PeaPle - A Decision Support System for Simulation of Postharvest Quality Changes in Fruit Supply Chains

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"PeaPle" is a decision support system (DSS) created within the framework of the FP6 European Integrated Project "ISAFRUIT", with the objective to simulate quality changes of apples and peaches along different supply chains, in order to meet the demands of consumers, and consequently increase fresh fruit consumption. "PeaPle" is a multi-cultivar system which allows the design of various supply chains from harvest until retail, with technological parameters (e.g. duration, temperature, storage atmosphere, etc.) set by the user. The user has the opportunity to compare the simulated quality decay of different chains using different sets of model parameters. The list of available models depends on selected fruit cultivar and location of fruit growth. The main quality parameters modelled for this DSS

are fruit firmness and acidity, but the list varies depending on available datasets used for models' parameterization. Since the level of quality decay depends on the maturity of the fruits at harvest, the user is asked for information on the initial fruit status. Then the stages of the supply chain have to be defined, including (CA) storage, transport and shelf life, as well as planned technological parameters for each chain stage. After defining the supply chain and running the DSS the user can generate the graph presenting quality changes along the defined supply chain, or create the report describing the different stages of the supply chain and presenting the status of the fruit batch at the end of each stage. The graph and report can be printed or saved as files. The sequence of supply stages, including their technological parameters can be saved for future use in the DSS. For better planning of the optimal supply chain, several chains can be simulated in one run and presented in a series of adjacent graphs or in one report.

### S11.031

#### Acceptability of Fruit of Several Peach and Nectarine Varieties as Related to their Ripening Stage Defined with Dameter

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Fruits of several peach and nectarine cultivars were monitored with the DAMeter (a simplified vis/NIR system device) to assess their ripening evolution on the tree. The peach and nectarine cultivars used for the trial, were selected on the basis of different flesh type (stony hard, melting, etc), skin and flesh colour. Two harvests/cultivar were performed at different ripening stages according to the IAD (Index of absorbance difference). This index is able to precisely define the ripening stage of the fruits. Moreover, in the packing house, fruits were further selected and grouped in uniform classes of ripening characterized by different IAD. Fruits were also characterised by standard quality traits as SSC, FF, and acidity content. Furthermore the shelf-life duration was determined as related to the fruit ripening stage value. To assess it the fruits grouped in uniform ripening classes were maintained at room temperature until the flesh firmness reached a value judged optimal for the consumption. Finally a large consumers test was organised in a supermarket to verify the acceptability of the consumers (perceived quality) and the buying intention for some fruits ripening classes.

### S11.032

#### Time Resolved Spectroscopy Analysis and Modelling of Firmness and Juiciness of Nectarines with and without Extended Storage

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Time-resolved Reflectance Spectroscopy (TRS) is a nondestructive technique utilizing the temporal delay experienced by a short laser pulse while travelling through a turbid medium, such as fruit flesh. The optical parameters of absorption coefficient ( $\mu_a$ ) and reduced scattering coefficient ( $\mu'_s$ ) measured at 670 nm and 760 nm were used to examine softening and juiciness of nectarine fruit held at 20 °C after harvest or after 30 days of storage at 0 °C or 4 °C. Each day for 5 days 30 fruit were examined both non-destructively and destructively. The fruit had been sorted at harvest according to the value of  $\mu_a$  670 nm so that each batch had a similar spread of fruit maturity. It was found that firmness decrease showed the same kinetics whether the fruits had been stored or not. Because of higher storage temperature, the 4 °C fruit were softer at removal from storage, but their softening at 20 °C was, nonetheless, similar in kinetics to the other two treatments. Wooliness in peaches, as a result of cold treatment, was determined by examining the extractable juice: the less juicy the fruit are, the woollier they will be. Fruit after storage (either 0 °C or 4 °C) had a decrease in juiciness during ripening and softening, while extract-



able juice increased in the non-stored fruit during softening. The measurement of  $\mu\text{a}$  760 showed a clear difference between stored and non-stored fruit, and may be a method of determining woolly fruit non-destructively. For modelling analysis the data were analysed using indexed non-linear regression. The standard errors of estimates for the rate constant are all very low, while those for the biological shift factor are rather high. This indicates that the model applied is too simple to assess the biological variation properly for this complex process. It gives, however, a first indication of what should be possible

### S11.033

#### Usefulness of Nondestructive DA, NAI and NDVI Indices for Monitoring of Ripening and Quality of 'Golden Delicious' and 'Jonagold' Apples during Harvest and Postharvest Periods

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The experiment was carried out in the 2008/2009 season within the activity of WP 4.2 of ISAFRUIT Project. Fruits of 'Golden Delicious' and 'Jonagold' were harvested nine and seven times, respectively. A few thousands of fruits were graded at harvest according to the DA index measured by DA meter (Sintéleia, Italy). The DA index is calculated based on fruit absorbance spectra, using formula  $A_{670}-A_{720}$ , where  $A_{670}$  and  $A_{720}$  are absorbances at respective wavelengths of 670 and 720 nm. For both cultivars the distribution and the number of classes distinguished by DA index changed during the harvest period. The DA index steadily decreased and more classes were presented for each subsequent harvest date. Graded fruits were stored at 10 °C and quality analyses (including standard measurements like fruit weight, background colour, internal ethylene concentration, fruit firmness, starch index, total soluble solids content and titratable acidity) were performed up to 20 times from harvest to the end of January 2009. Additionally, nondestructive measurements using DA meter and CP Pigment Analyzer PA1101 (Control in Applied Physiology GbR., Germany) were conducted. The spectral data from CP were used for calculation of two standard indices: Normalized-Differenced-Vegetation-Index  $NDVI=(I_{780}-I_{660})/(I_{780}+I_{660})$  and Normalized Anthocyanin Index  $NAI=(I_{780}-I_{550})/(I_{780}+I_{550})$ , where  $I_{550}$ ,  $I_{660}$  and  $I_{780}$  are reemittances at respective wavelengths of 550, 660 and 720 nm. During storage fruits of individual classes, as distinguished at harvest were analyzed. Collected data showed that within each class a few sub-classes were found during storage. The changes of the indices and quality parameters during fruit ripening as well as the usefulness of the tested nondestructive methods for monitoring fruit ripening and quality are discussed.

### S11.034

#### Profitfruit: Decision Support System to Evaluate Investments in Fruit Production

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Innovative techniques were developed in the Isafruit project in order to create a more ecological sustainable way of fruit growing. To be implemented by fruit growers these innovations should also be economically sustainable. Therefore, in the Isafruit project also an economic model, Profitfruit, was made. Profitfruit includes a database containing quantitative data on fruit growing in three European fruit growing regions: North Germany (Jork), Switzerland and The Netherlands. Data include costs, prices, production and labour demand for apple growing. The model calculates both returns, gross margin, marginal gross margin, fixed costs as well as labour income entrepreneur. In this study, Profitfruit is used to study the economic effects of three different innovations: the Isafruit spraying machine, the hot water treatment for prevention of storage rot, and the mechanical thinning apparatus. The comparison includes a sensitivity analysis for the critical factors: investment costs, quality and quantity of the production, storage loss and labour demand. Economically the spraying machine has the highest potential. It results in lower costs and

therefore higher returns. This means that fruit growers might be willing to invest in this technique. However, it is important to keep in mind that the economic effects depend highly on farm size. Hot water treatment leads to higher costs for fruit growers, which will limit the number of growers willing to use such techniques, unless the high labour demand, energy use and costs for antagonists can be reduced. Mechanical thinning has little perspective. For positive effects the mechanical thinning needs to result in a higher quality of the production. It is concluded that additional costs, labour demand and high yields of first quality fruit are critical success factors for innovative techniques which are meant to save the environment.

### S11.035

#### International Comparison of the Apple Production

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Because of the large apple production in 2009, apple growers in Europe are faced with a high price drop. The evaluation of the current situation in different countries and the development of possible strategies to improve apple production are fundamental for European apple growers. Within the ISAFRUIT project we compared data of four main growing apple regions like the North of Germany, the South of France, the Netherlands and some parts of Switzerland. First, we identified and second, we compared important production-related (e.g. yield and grading results) and economic (working hours and producer prices) dimensions between the above-named countries. Using the enlightening method of the SWOT analysis (S=strength, W=weakness, O=opportunities and T=threats) we will develop different strategies for apple growers in these regions to proceed their apple production in a sustainable way.

### S11.036

#### Standards, Legislation and Growers Demands as Drivers of Progress in Spray Application Technology

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Over the last decades spraying Plant Protection Products (PPP) has changed. Not so much the process itself, we still bring out water as a carrier to distribute the active ingredient as evenly as possible over crop canopies or fruits. The sprayer itself has not changed much either. It is more the boundary conditions, the environment and the public awareness of PPP on the consumable products that determines how to spray. Technology has given answers to the questions: how to minimise spray drift, how to optimise spray distribution over canopy and how to minimise PPP use to increase product quality. It is in the perspective of these developments that an overview is made of relevant developments in the past and present, and an outlook is given to future developments in fruit crop spraying. The role of environmental legislation (Water Framework Directive, TSSUP), industrial standards (Machine Directive), consumer preferences (healthy fruit, zero residues) and grower's demands (personal safety, labour, field capacity, low costs) are taken as a guideline to describe these processes. The technological answers are e.g. matching spray volume to tree sizes and shapes which can reduce chemical application, thus reducing operational costs and environmental pollution. Also, tree-specific variable volume precision orchard sprayers, guided by foliage shape and volume (canopy density sprayer; CDS) were developed. Sensor development and the use of sprayer positioning tools linked to mapped tree information from a GIS by RTK-DGPS are presented to show their effects on spray deposition, biological efficacy and spray drift. Based on the need to reduce expensive labour time, future perspectives towards the development of autonomous driving machines are given. Future developments will also focus on monitoring and recording of the activities to assist the fruit industry and give compliance with GLOBALGAP, traceability and farm management systems.

### S11.037

#### Variable Rate Application with Crop Identification System to Reduce Pesticide Input in Fruit Growing

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An environmentally friendly orchard sprayer has been developed within the European Project ISAFRUIT. The sprayer is able to automatically adapt the application according to the characteristics of the canopy target (size and density), to the level of disease present in the canopy and to the environmental conditions (wind speed and direction). For the identification and the characterisation of the target, a Crop Identification System (CIS) based on ultrasonic sensors was developed by DEIAFA and 3B6 company. During 2008 season the CIS system mounted on the ISAFRUIT air-assisted sprayer prototype was tested in an apple orchard in order to assess spray deposits on leaves and fruits, ground losses and biological efficacy of treatments. Results were compared with those obtained using a conventional air-assisted sprayer. Tests were made in an apple orchard (cv. Gala) featured by a layout of 3.8 m (row distance) x 1.0 m (plant spacing) and with average tree height of 4.0 m. Spray deposition tests pointed out that either at the development of fruits growth stage (BBCH 71) or with full vegetation (BBCH 91) the ISAFRUIT sprayer equipped with the active CIS, applying only about 50% of the reference volume, enabled to obtain analogue spray deposit on the leaves as achieved switching off the sensors. For what concerns deposition on fruits, slight differences were observed among the average spray deposits obtained in the different treatments examined. Results of biological tests pointed out that the incidence of apple scab and of powdery mildew on leaves and on fruits observed respectively at the end of June and at harvest time, were very low and no statistical differences resulted between the CIS sprayer and the conventional axial fan sprayer.

### S11.038

#### Reduction of Environmental Impact of Pesticide Application in Fruit Growing by Novel Environmentally Dependent Application System - EDAS

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The new EU directive on sustainable use of pesticides (2009/128/EC) and recently revised machinery directive (2006/42/EC) set the environmental requirements on pesticide application methods and spray equipment. The measures to protect the aquatic environment and drinking water supplies from the impact of pesticides should be adopted. This can be achieved by using spray drift reducing techniques and/or performing the treatments according to drift reducing application scenarios. The latter requires monitoring of weather conditions and precise identification of sensitive areas to be protected (e.g. water bodies) and appropriate change of application parameters when approaching these objects in order to mitigate drift and hence reduce risk of contamination according to wind situation. The automatic performance of such application scenario was an objective of development of the Environmentally Dependent Application System (EDAS) within EU project ISAFRUIT. The EDAS identifies a wind velocity and direction by ultrasonic anemometer and by GPS the sprayer position in relation to the edge of orchard and sensitive areas and automatically adjusts application parameters according to this variable environmental circumstances. The spray quality is adjusted by selecting the nozzles (fine spray/coarse spray) in order to minimise the spray drift, or by shutting off the appropriate nozzles to respect the local standards for buffer zones. The supporting air jet is adjusted individually for the left and right side of the sprayer by manipulation of airflow on the inlet and outlet of the fan of innovative design. A control unit and software were developed to control both spray emission and air discharge systems in various situations, and to integrate them with GPS. Compared to conventional applications with fine spray nozzles and full air flow the reduction of spray drift by over 80% was obtained for application scenarios with coarse spray nozzles and reduced airflow set automatically at proximity of sensitive areas.

### S11.039

#### Effects of Hot Water Treatment on Monilinia Rot and Quality of Stone Fruits

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Traditionally in Europe, brown rot management in stone fruit has been accomplished in the orchard by means of fungicide sprays, since post-harvest (PH) treatments are not allowed. Many environmental-friendly and safer alternatives and/or integration to pre-harvest fungicide spray, like heat treatments (hot water dips, hot water rinsing and brushing, warm air), natural substances and salt treatments, were evaluated in recent times. However none of them are extensively applied in commercial packing houses. The aim of the research was to determine the best conditions for hot water (HW) treatment to control *Monilinia* rot in peach and nectarine during storage and shelf life. In a preliminary trial 'Springbelle', 'Rich Lady' peaches and 'Stark Redgold', 'Big Top' nectarines were dipped in water at 60, 65 and 70 °C for 20, 40 and 60 seconds. Dipping both peach and nectarine in water at 65 or 70 °C caused skin damage as well as at 60 °C for 40 and 60 seconds, while no detrimental effects was observed at 60 °C for 20 seconds. This treating condition was chosen for subsequent studies. After treatment the fruit were kept for 4-6 days at 20 °C or for 20-30 days at 0 °C followed by shelf-life (4 days at 20 °C) depending cultivar. In all trials, *Monilinia* spp. natural infections were reduced significantly, with an efficacy index ranging from 82.3 to 100 % in peaches ('Rich Lady' and 'Springbelle' respectively) and from 71 to 100 % in nectarines ('Stark Redgold' and 'Big Top' respectively). In a further trial, HW applied to organic fruits, reduced *Monilinia* infections by 87% and by 43% respectively in 'Benedicta' white peach and 'Caldesi 2010' white nectarine. Quality parameters: firmness, solid soluble and acidity were not affected by HW as well as appearance, texture and flavor.

### S11.040

#### Combination of Hot Water, *Bacillus subtilis* CPA-8 and Sodium Bicarbonate Treatments to Control Postharvest Brown Rot on Peaches and Nectarines

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Brown rot caused by *Monilinia* spp. is the main disease affecting postharvest of peaches and nectarines in Ebro Valley (Spain). Nowadays, any postharvest chemical treatments are not authorized to be applied on stone fruit in several countries, increasing the interest and the need for developing alternative treatments. The aim of this study was to evaluate the effect of hot water (HW), antagonists and sodium bicarbonate (SBC) treatments applied separately or in combination to control *Monilinia* spp. in postharvest of stone fruit. Firstly, we investigated the effect of HW temperatures (55-70 °C) and exposure times (20-60 s), seven antagonists at two concentrations (107 or 108 cfu·mL<sup>-1</sup>) and four SBC concentrations (1-4%). The selected treatments for brown rot control without affecting fruit quality were HW at 60 °C for 40 s, SBC at 2% for 40 s and the antagonist CPA-8 at 107 cfu·mL<sup>-1</sup>. The combinations of these treatments were evaluated in three varieties of peaches and nectarines artificially inoculated with *M. laxa*. When fruit were incubated for 5 d at 20 °C, a significant additional effect to control *M. laxa* was detected with the combination of HW and the antagonist CPA-8 (*Bacillus subtilis* species complex) being the average of brown rot 8% in comparison with 84%, 52% and 24% for control, antagonist and HW treatments, respectively. However, the other combinations tested did not show a significant additional effect against *M. laxa* in comparison with applying the treatments separately. When fruit were incubated for 21 d at 0 °C plus 5 d at 20 °C, the antagonistic activity of CPA-8 against *M. laxa* was markedly decreased. Moreover, the significant differences between separated or combined treatments were reduced and generally the incidence of brown rot was higher than at 20 °C. Similar profiles were observed testing fruit with natural inoculum.

## S11.041

### Seasonal Regulation of Fruit Development, Abscission, and Postharvest Quality - A Case Study of Apple

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Apple fruit development is a complex process where dynamic changes in growth processes, responses to competition, and environmental variation affect fruit growth rate, harvest quality and postharvest characteristics. Many effects found at harvest and postharvest have origins during the early cell division period. Many orchard variables have their influences via effects on mineral composition and/or maturity. Fruit size potential is controlled by early cell division and final cell numbers. A key factor affecting cell numbers is carbon supply to fruit and early competition. Early fruit growth rate is strongly related to carbon supply to the fruit, and is critical for fruit retention. Normally this depends on light availability and temperature, competing vegetative and fruit sinks, and exposure of extension shoot versus spur leaf area. Cell size, which is largely determined by environment later in the season, leads to the final fruit size attained. Mid-to-late-season fruit growth rate can be limited by excessive crop loads or environmental or pest stresses. Carbohydrate accumulation in the fruit also appears to affect the ability of the fruit to withstand stresses of storage temperature, low oxygen and radically different environment compared with preharvest. Carbohydrate modeling has been useful in integrating environmental and tree physiological responses during the key early season and has contributed to optimizing crop thinning. In addition to carbon supply, fruit mineral uptake and concentration in the fruit have been related to fruit quality at harvest. Fruit Ca content is positively related to early-season uptake but final concentration is affected by later growth dilution. Other fruit mineral nutrients are important to postharvest quality and have critical preharvest relations. Weather conditions later in the season also have been correlated with fruit quality at harvest and after storage. Integrating seasonal physiology to determining critical measurements during the season is a current challenge.

## S11.042

### Light Reduction as Environmental Sustainable Thinning Agent in Apple: A Modelistic Approach

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The environmental sustainability of fruit production is an important issue to deal with. Findings from previous studies showed that a strong but temporary light reduction could be used as a thinning method to induce fruit drop without chemical thinners. Following the hypothesis that C-starvation may induce fruit abscission, shade is a possible way to thin apple trees. However, a method is needed to determine the length of shade because the strong reduction of incoming light for a very long time causes all the fruit to drop. Thirty days after full bloom (DAFB), six 'Imperial Gala' apple (*Malus x domestica* Borkh.) trees were covered with a 90% shading net. Trees were uncovered in different days, leading to six different shading durations (10, 7, 6, 5, 4, 3 days). During the experiment tree gas exchanges were continuously monitored using a whole canopy enclosure method and the daily carbon gain per tree was determined. The "Malusim" dry matter production and partitioning model developed by Prof. Alan Lakso using Stella modelling software was applied in order to simulate the six trees daily carbon balance. Apple trees carbon gain and fruit drop were affected by shading duration. During the 10 days of whole canopy gas exchange trial the total net carbon uptake ranged from -50 to 500 g per tree corresponding to a percentage fruit drop of 90 and 60, respectively. A goodness-of-fit analysis between observed and predicted daily carbon balance yielded a range of values between 0.76 and 0.95. Nevertheless, in some cases a

consistent overestimation of daily carbon balance was observed. This variability and lack of accuracy can probably be ascribed to the fact that several of the model parameters have not been optimised yet for the environmental conditions of Bologna, as well as some of the tree responses to these conditions.

## S11.043

### Crop Regularity and Fruit Quality - When Tree Manipulation and Genetics Need to Meet

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Training and pruning strategies of fruit trees are developed for better fruit quality and higher regularity of bearing. They are, however, only a part of the many factors the grower has to assemble to improve orchard profitability. Based on trials carried out in the framework of the ISAFRUIT programme, our aim was to critically analyze interests and limits of some current training and pruning concepts. We compared the Centrifugal Training system based on extinction pruning, ie the selective removal of flowering spurs to improve tree functioning and fruit quality, and two other reference training systems. The first one, the Solaxe, developed in France during the 90s is mainly based on the bending of branches to better manage tree shape and accelerate entrance into production. The second one, the Structured Axis, is used in many countries and aims at establishing a strong branch framework through annual heading cuts. Our study pinpoints the following results. First, in a given year and for a same fruit load (number of fruits/cm<sup>2</sup> TCSA), Centrifugal Training generally increased mean fruit size and color. These results lend further support to the idea that the way crop load is managed plays a significant role in fruit quality. Second, Centrifugal Training tended to increase, or had no effect on, return-bloom depending on the cultivar. These results suggest that if training and pruning strategies are able to improve fruit quality in the "on year", it is hardly able to improve regular bearing on strong alternate bearing cultivars. Our study thus emphasized the need to develop collaborative works between ecophysicists and morphologists on the one hand, and geneticists and breeders on the other hand, to select not only cultivars with high fruit quality and resistance to pests and diseases but also with a high ability for regular bearing.

## S11.044

### Rapid and/or Non-Destructive Analytics to Measure and Monitor Fruit Quality

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Novel analytical tools and data analysis methodologies can play an important role in order to promote and preserve fruit quality. Non-invasive and/or rapid methods allow increased sampling, online produce quality monitoring and process follow-up during the entire production and supply chain. At the Research Station Agroscope Changins-Wädenswil ACW, several spectroscopic methods (VIS, IR, NIR, NMR) have been examined for the non-destructive measure of pre- and post-harvest quality parameters in fresh fruit and vegetables. Near-infrared spectroscopy appears to be one of the most promising approaches. Classical quality parameters, such as texture, soluble solid content and titrable acidity, can successfully be assessed through a rapid and non-invasive NIR measurement. Nevertheless, aroma, probably one of the most important quality attributes for the consumer, cannot be effectively assessed by this method. A new generation of "electronic noses", that couple directly headspace sampling with mass-spectrometry (MS) detection, may enable the rapid characterisation (fingerprint) and the follow-up of fruit aroma. In this study, 3 different NIR devices (NIR Case of SACMI/IT, DA-Meter of Sintéleia/IT, Phazir of AnalytiCON/DE) as well as a MS-based electronic nose (SMartNose<sup>®</sup>, SMart Nose SA/CH) were evaluated for the rapid and/or non-de-

structive measure of quality parameters along the production and supply chain: - The pre-harvest quality (ripening monitoring) of pomaceous and stone fruits was followed up by NIR portable instruments; - Changes in fruit quality during storage (post-harvest quality) were monitored by NIR and electronic nose; - NIR and electronic nose measurements were carried out to support the sensory analysis of apples after storage (sensory quality). Although these analytical approaches have been proven very promising, further research and thorough method validation are still needed before their implementation can represent a tangible advantage for producers and consumers.

### S11.045

#### Control of Storage Rots of Apple

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The main UK apple cultivars Cox and Bramley are susceptible to a range of fungal rots that cause losses in store. Trials were conducted 2005-2008 to (1) evaluate GRAS (Generally Regarded As Safe) chemicals to identify products that could be used as post-harvest treatments to control rots (2) Evaluate fungicides for early season control of orchard diseases, especially *Nectria galligena* and (3) Evaluate combined treatments for control of orchard and store diseases. A range of GRAS chemicals were evaluated in small scale inoculation experiments for their efficacy in controlling the wound pathogens *Botrytis*, *Penicillium* and brown rot (*Monilinia fructigena*). Only Chitoplant (chitosan) and Wetcit (alcohol ethoxylate) consistently showed some control of botrytis. In orchard trials on cv. Cox conducted 2005-2007 fungicides applied at blossom and petal fall were compared for effectiveness in controlling latent infections of storage rots especially those due to *N. galligena*. Captan, thiophanate-methyl and pyraclostrobin + boscalid (Bellis) were most effective and consistent in reducing rotting in store. In 2008, trials were established in three Cox orchards at East Malling Research to compare early season fungicide treatments and selective picking (avoiding damaged fruit and low-hanging fruit) with post-harvest hot water treatments (HWT, 52 °C for 40 sec.) and GRAS chemicals (Wetcit) for control of storage rots. The fruit was stored in CA at 3.5 °C, 1.25%O<sub>2</sub>, <1%CO<sub>2</sub> until February when the incidence of rotting was assessed. Overall, fungicide treatments applied at blossom and petal fall were effective in reducing the incidence of nectria rot in store. HWT also reduced the incidence of latent rot in store but has many practical difficulties as a method of controlling latent rots compared to orchard fungicide sprays. The incidence of wound rots (*Penicillium* and *Botrytis*) was too low to evaluate the efficacy of Wetcit compared to selective picking.

### S11.046

#### Molecular and Genetic Analysis of the Developmental and Signaling Systems Controlling Tomato Fruit Ripening

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The ripening and development of fleshy fruits is regulated by environmental, hormonal and developmental cues. Ethylene is the key ripening hormone of climacteric fruits and can influence ripening in many non-climacteric fruits. Our laboratory uses tomato as a model system to understand ripening regulation and has identified a number of necessary ripening genes via positional cloning of loci underlying ripening mutations and transcriptional profiling studies of ripening associated gene expression. To date we have identified six transcription factors that we have shown to be necessary for tomato fruit ripening via transgenic studies including two MADS-boxes, two NAC domains, an Ethylene Response Factor (ERF) and an APETALA2 gene homolog. One of the MADS-box genes, TAGL1, is especially intriguing in that it suggests a molecular link between fleshy fruit development and eventual ripening via a single gene product. A summary of these gene activities in the context of other reported regulatory and ethylene response genes will be presented.

### S11.047

#### Genetic Analysis of Peach and Apricot Fruit Characters Based on QTL Analysis and Candidate Gene Co-Locations

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Knowledge of the genetic basis of fruit quality is one of the key elements for the development of adequate tools and strategies for the improvement of this complex character. In ISAFRUIT we have followed a candidate gene (CG) approach for this purpose in two stone fruit crops, peach and apricot. A large number of CGs potentially involved in fruit flavor, aroma, softening and color, were selected and bin-mapped in the TxÉ *Prunus* reference map, based on an interspecific almond x peach F2 population. The positions of 131 of the 163 CGs selected were established in this map. QTL analysis was performed in four progenies of *Prunus*: two involving peach (a peach x peach F2 and a peach x *P. davidiana* second backcross using peach as the recurrent parent) and two F1 segregating progenies apricot x apricot. These populations were analyzed during two years for 9 agronomic characters, 14 measurements related with organic acid and sugar contents and 20 with phenolic compounds. Numerous QTLs were found in each population for the phenotypic characters studied. For certain specific QTLs, additional markers were used to saturate their chromosomal regions and some of the CGs were mapped in the populations studied. Interesting co-locations between QTLs and the CGs mapped will also be presented in this communication.

### S11.048

#### QTLs Involved in Phenological Traits in Several *Prunus* Species (Peach, Apricot and Sweet Cherry)

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Nowadays, there is growing concern on the ability of numerous plant species (both in natural or cultivated ecosystems) to adapt to the global climate change. Within tree fruit species, an increasing evidence shows that advances in blooming dates, as well as phenological disorders, can be linked to temperature increases during periods of dormancy (autumn, winter) and bud burst (spring). In order to anticipate these negative trends and to safeguard tree fruit production in Europe, classical plant breeding programs must incorporate into their selection criteria traits related to adaptation to the climate change. Phenological traits including blooming and maturity dates, as well as the fruit length development, were evaluated on several *Prunus* species during three to seven years according to the species. In peach (*P. persica* L. Batsch), two progenies were analyzed, one is an intraspecific F2 issued from Ferjalou Jalousia® x Fantasia cross and the second is derived from an interspecific cross between the peach Summergrand and the clone P1908 of a wild species related to peach (*P. davidiana*). In apricot (*P. armeniaca* L.), two F1 progenies were analyzed, one derived from the cross Lito x BO81604311 was evaluated for maturity date, and one Goldrich x Moniqui was evaluated for blooming and maturity dates. In sweet cherry (*P. avium*), an F1 progeny derived from the cross between

varieties 'Regina' and 'Lapins' was evaluated for blooming and maturity dates. The stability of the detected QTLs across years will be examined. The QTLs detected in each species will be compared in order to evaluate the synteny level within the *Prunus* genus for these phenological traits. More over, based on QTLs already detected in *Malus*, comparison between *Malus* and *Prunus* will be undertaken.

## S11.049

### Inheritance of Fruit Flesh Phenolic Compounds in Peach and Apricot: Identification, Quantitative Variations and QTL Comparative Mapping

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Fruit quality is one of the characteristics expected by consumers in *Prunus* species such as peach and apricot. Mainly based until now onto fruit attractiveness, texture and primary metabolites, an increasing interest exists in secondary metabolites, including phenolic compounds, in connection with their potential beneficial role in human health. In the course of the ISAFRUIT European Integrated Project, a study of the inheritance of fruit phenolics was undertaken on four *Prunus* progenies, segregating for important quality traits. Two peach populations bred in France (an interspecific BC2 progeny derived from the wild peach-related species *Prunus davidiana* and an intraspecific F2 progeny) and two intraspecific apricot progenies bred in Italy and France were studied. Flesh phenolic content was analyzed by HPLC-DAD on mature fruits of about 120 hybrids and their parents for one or two years depending on the population. Phenolic profiles of apricot and peach were compared. About eighty phenolic compounds were detected in the flesh of each species. Eight were identified, among which hydroxycinnamoylquinic acids (mainly chlorogenic acid and its isomer, neochlorogenic acid), flavanols and procyanidins (catechins, epicatechins and oligomers). Levels of the most abundant compounds were analysed. They showed important variations among hybrids of each progenies. Most of the distributions departed from normality. Bimodal distributions were also observed for few compounds. QTL analysis was conducted for each progeny using SSR-based genetic maps already obtained and anchored to the general *Prunus* map. The main genomic regions (QTLs) involved in the control of phenolic compound contents were detected and the localization of these QTLs was compared. Consequences for apricot and peach breeding for high levels of health-promoting compounds are discussed.

## S11.050

### Identification of QTLs for Cell Wall Determinants in Apple Texture

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Apple texture relies on turgor pressure, histology and cell wall chemistry. As a prerequisite in the identification of genetic markers controlling these components for future Molecular Assisted Breeding, the variability of mechanical, sensory, histological and cell wall components were analyzed in an apple progeny of 150 individuals and their parents. Apples were harvested in 2007 and 2009 and phenotypic traits were measured after 2 months storage at 1.5 °C. Texture analysis involved sensory evaluation as well as penetrometry and compression mechanical analyses. Images were acquired from ~1 cm<sup>2</sup> sections and analyzed to estimate mean cell size and intercellular spaces proportion. Non-starch sugar composition of isolated cell walls as alcohol insoluble material was quantified by GC and colorimetry after correction for starch

content measured by amylolysis and HPLC. Hemicelluloses fine structure was determined by combining glucanase degradation and MALDI-TOF MS of products. 83 microsatellites were mapped. In order to detect QTLs, a saturated genetic map was constructed using Join-Map4<sup>®</sup> software. Sensory analyses showed large variations in the progeny and revealed few mealy hybrids. Penetrometry and compression data characterizing firmness distributed homogeneously within the population as did cell mean size and proportion of intercellular spaces. Biochemical results showed that glucose and uronic acid represented 60 % of cell wall weight. Index of dispersion of molar sugar composition was the highest for galactose (0.22) and then for uronic acid (0.17). Hemicellulose analysis revealed a large variation in fine structure of xyloglucans. The highest index of dispersion was observed for the XXXG structure (6.7). Principal component analysis of all data showed a close correlation between histological, compression and crunchy perception data. QTLs analysis for these characters will be presented and discussed with focus to apple fruit texture.

## S11.051

### Towards an Understanding of Genetic and Molecular Bases of Apple Flavour

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Flavour is among the key factors of apple fruit quality. Improving sensory quality is an important but complex breeding goal. Apple fruit volatiles are secondary metabolites and considerably affect aroma and herewith the sensory quality of an apple variety. During domestication and (resistance) breeding the pattern of volatiles has been subjected to qualitative and quantitative changes that were not always positive for the trait aroma. Therefore, detailed genetic and molecular knowledge about the most important biosynthetic pathways is needed to more efficiently select apple genotypes with favourable aroma patterns. The objective of the presented research was to identify and map candidate genes possibly involved in apple aroma production and to study their putative co-localization with known QTLs for single volatile compounds. A further objective was to assess the allelic diversity of selected candidate genes. Sequencing and analysis of the allelic diversity might support the development of functional markers for the most important key genes involved in volatile biosynthesis. In the candidate gene approach, ten new genes were mapped in the apple genome and located on eight linkage groups (LG). Each of the candidate genes was localized within confidence intervals of previously determined volatile QTLs. Two candidate genes, tentatively designated LOX2 and AAT2, were mapped in genomic regions where two of the three most important volatile QTL clusters were identified. The LOX2 (lipoxygenase) candidate gene on LG 9 locates within the confidence intervals of QTLs for six different fruit esters. The second important relationship detected concerns the candidate gene AAT2 (alcohol acyl transferase) and the QTL cluster on LG 2 containing QTLs for the quantitatively most important acetate esters such as hexyl acetate, butyl acetate, and 2-methyl butyl acetate. First results on allelic diversity evaluated by direct sequencing in a collection of 50 apple cultivars are presented.

## S11.052

### QTLs for Fire Blight (*Erwinia amylovora*) Resistance in *Pyrus ussuriensis* 18

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Creation of new pear cultivars resistant to fire blight will contribute to limitation of chemicals use, a requirement for organic production. The first step to obtain

this goal is identification of genes controlling resistance. For the first time genetic linkage maps were constructed for European pear cv. Doyenne du Comice and for species *P. ussuriensis* using F1 mapping population. Map of 'Doyenne du Comice' consists of 81 loci divided into 19 linkage groups (LG) and spanning genetic distance of 864,261 cM. A genetic linkage map of *P. ussuriensis* comprises 80 loci mapped on 19 LGs in a total length of 827,786 cM. They cover 85% and 81% of pear genome, respectively. For the first time QTLs for fire blight resistance in *P. ussuriensis* were identified in its LGs U9, U\_a, U\_e and U\_g as well as in U11, in which till now source of resistance to this disease has never been found. QTLs identified in LGs U\_e and U\_g are linked to AFLP-RGA markers, what additionally confirms presence of resistance genes in this LGs. QTL in LG U9 explains 61.9% of resistance trait variation in the progeny, what indicates that this is the main QTL transmitted by father. Remaining identified QTLs explain 31.5% of resistance trait. Despite the high susceptibility of 'Doyenne du Comice', 4 QTLs for fire blight resistance were found in this cv. These QTLs were localized in LG K3, K4, K11 and K\_a. They explain 25.6% of quantitative trait variation. These data confirm existence of interspecific **transgression phenomenon**, also previously observed on the base of infection level evaluation of seedlings belonging to the studied hybrid family. Presence of QTLs with small effect in 'Doyenne du Comice' testifies that sources of fire blight resistance are present also in susceptible genotypes.

### S11.053

#### The Biology and Genetics of Human Sensory Perception: Implications for Research on Whole Fruit and Fruit-Based Products

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The genetic basis of human sensory perception is a focus of a number of research groups including our own. We have found significant variability in the ability of humans to perceive a cis-3-hexen-1-ol, a volatile associated with 'green' and 'grassy' odours in many foods, and a key contributor to the flavour of kiwifruit. Preliminary evidence has been published suggesting that human perception of a cis-3-hexen-1-ol may be associated with one or more odour receptor genes located on chromosomes 6 (Jaeger *et al.*, 2010). In this presentation, we consider the implications of the diversity in human ability to perceive specific volatiles on the ability of researchers to collect data on orthonasal and retronasal odour using trained panels and expert panels as well as in consumer studies. Access to information on the olfactory ability of participants in sensory and consumer studies has the potential to revolutionise our understanding of the data they provide. Furthermore, we consider how perception of flavour may change profoundly when volatiles are introduced into a more realistic food matrix – in our case by injecting flavour essences into pieces of fruit. Finally, we focus on the role of sensory appeal as one of the elements of success in the development of fruit and fruit based products (beverages and ingredients).

### S11.054

#### Breeding Fruit Crops in the USA Using Socio-Economic and DNA Information

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A wide array of fruits and fruit products is now commonly available to the U.S. population, yet per capita consumption remains static and does not come close to meeting recommended dietary intake. U.S. producers of crops in the *Rosaceae* (almond, apple, cherry, peach, pear, raspberry, and strawberry) face economic challenges as costs and marketplace competition increase. A new coordinated research and extension project with a significant socio-economic scientific component has been funded by the U.S. Department of Agriculture to translate genomics research into more efficient breeding of fruit crops with real impact in the marketplace. This four-year project, called "RosBREED: Enabling marker-assisted breeding in *Rosaceae*," ([www.rosbreed.org](http://www.rosbreed.org)) has a number of similarities to ISAFRUIT and will enhance rapid development and deployment of new cultivars with improved characteristics to meet dynamic industry and market needs and consumer preferences. Beginning in late 2009, the project has an overall budget of 14 million (\$US), involves scientists from a range of disciplines, and includes eleven U.S. organizations and six international partners. Its focus on socio-economic factors underlying industry values and consumer preferences is intended to drive a genomics-to-marketplace approach that more directly informs its twelve core breeding programs and engages the entire supply chain, including producers, market intermediaries, and commodity organizations. The concurrent establishment of a technical infrastructure for DNA-informed breeding will integrate breeding efforts and genomics resources, exploit the shared ancestry of *Rosaceae* crops, help train the next generation of plant breeders, reinforce cross-disciplinary linkages with allied scientists, and thoroughly engage industry stakeholders. We expect RosBREED will help increase the likelihood of new cultivar adoption, enlarge market potential, and increase consumption of rosaceous fruits. This presentation focuses on the project's socio-economic and extension aspects.

### S11.055

#### Marker-Assisted Selection for Fruit Quality and Disease Resistance in Apple

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For perennial crop such as apple (*Malus xdomestica*), marker-assisted selection (MAS) can improve breeding efficiency, especially if performed at an early stage. In the frame of the Isafruit European project ([www.isafruit.org](http://www.isafruit.org)), an experiment was conducted at INRA to evaluate its potential. Genetic bases of apple fruit quality (texture, sugar content, acidity, juiciness ...) have been partially elucidated thanks to QTL genetic mapping, especially in the frame of the European research project HiDRAS (Gianfranceschi and Soglio, Acta Hort., 2004). Major resistance genes and resistance QTL against scab (*Venturia inaequalis*) have also been mapped (e.g., Calenge *et al.*, Phytopathology, 2004). Microsatellite (SSR) markers closely linked to QTL were identified, which makes it possible to implement practical marker-assisted breeding. About 2,800 seedlings deriving from 3 controlled crosses were genotyped with these SSR markers. The controlled crosses were chosen according to the knowledge we had on the linkage phases between linked SSR and target QTL for the parents. For each seedling, the probability of the favorable allele presence (PFAP) was inferred for each QTL according to the available marker data. A selection index was computed for each seedling by weighting each QTL PFAP with a coefficient decided according to the breeding importance of the trait and R<sup>2</sup> value of the target QTL. The global selection index was thus a linear combination of weighted PFAP. By ranking seedlings according to their respective selection index value, MAS was performed either

positively (higher selection indexes) or negatively (lower selection indexes). To evaluate MAS efficiency, ~100 positively selected (MAS+) seedlings, ~50 negatively selected (MAS-) seedlings, and ~50 randomly chosen (MASr) seedlings were retained per progeny and will be evaluated in the field. This MAS approach will be presented and discussed.

### S11.056

#### Pomace of Scab-Resistant Apples as Raw Material for Biocomponent Preparations - An Alternative for Classic Utilization of Side Product

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Apples are the fruits processed in large amounts to juices, which results in large quantities of side product - pomace, which contains large quantities of phenolic components. Classic utilization of apple pomace is limited to production of pectin preparations, dietary fibres or using it as animal food or fuel. Large quantities are just being composted. Biocomponents contained in pomace are normally neglected. Scab-resistant cultivars are of great interest for many growers and are being researched as a raw material for production of juices. Such production results in pomaces diversified by their compositions. The objective of the presented study was to assess the pomaces from selected scab-resistant apple cultivars as a source of biocomponents and to prepare and characterize two kinds of products concentrates containing biocomponents and post-extraction dietary fibre preparations, characterized by desired dietic properties. Pomaces from selected apple cultivars and a pomace from industrial mix of cultivars were subjected to water extraction, resulting in raw polyphenol-sugar extracts, which were next purified on absorption bed. Parallel product obtained from water extraction was post extraction pomace, which after drying and suitable grinding resulted in post extraction dietary fibre. Purified extracts were characterized by high concentration of polyphenols – above 16 to 26%, with high (above 60%) contribution of quercetin glycosides. Post extraction pomaces were characterized by high total dietary fibre contents and cultivar-dependent contributions of soluble dietary fibre. Obtained product was subjected to application trials.

### S11.057

#### Development of Symbiotic Apple Slices

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The market for fresh-cut fruits is rapidly growing due to an increased consumer demand for healthier and more functional foods. Apples are well known as a healthy product and are therefore an excellent base for a more functional food. Regular consumption of pre- and probiotics have been reported to improve gut and immune health. Therefore the aim of this study was to apply two functional food ingredients to fresh-cut apple wedges i.e. a probiotic microorganism and a prebiotic in form of fructooligosaccharide. A probiotic microorganism (*Lactobacillus rhamnosus* GG; LGG) was applied as a dip (containing approximately log 10 cfu/ml) to the fresh-cut apple slices which were then drained and dipped in Natureseal AS1 browning inhibitor. An edible sodium alginate film solution containing the prebiotic was then applied to the apple wedges. Wedges were then drained and packed in clear trays using a heat-sealed film followed by storage at 2 - 4 °C. LGG was enumerated on each test day on whole wedges and has shown good survival and adherence without the coating. Future trials will focus on the effect of the prebiotic coating on the counts of probiotic bacteria and on physicochemical properties of the apple wedges. HPLC and GC-MS will investigate the effect of pro- and prebiotics on the content of polyphenols and the volatiles of the apple wedges.

### S11.058

#### Effect of Thermal and High Hydrostatic Pressure (HHP) Processing on Polyphenol Content of Fruit Smoothies

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Fruits are an important source of polyphenols. Polyphenolic compounds play a role in the quality of fruits as they serve to protect them from oxidative deterioration. Many of these protective qualities of polyphenols in fruit could confer health benefits on the consumer. Increased consumption could lead to a decreased incidence of many chronic diseases resulting from the anti-inflammatory activity of polyphenols present in fruit. Fruit smoothies are an increasingly popular way of consuming fruit. Minimally processed fruit products appeal to consumers as they are convenient and are perceived as healthy. HHP can produce foods with fresh characteristics that are high in nutritional and sensory quality, with an extended shelf-life. Thermal processing offers similar benefits but can lead to flavour impairment and unwanted textural changes. The aim was to investigate the effect of thermal and HHP, processing on the polyphenol content of fruit smoothies. Samples were prepared with apple (29.5), apple juice (29.5), strawberry (21), banana (12) and orange (8%). HHP samples were processed using isostatic pressure (450 MPa), held for 1, 3 and 5 min. Thermally processed samples were heated in a Barriquand Retort until a time-temperature equivalent (P70>10 min) was reached. Samples were stored at 2-4 °C and freeze dried on days 1, 10, 20 and 30. Methanolic extracts were prepared and stored at -20 °C. HPLC-analysis and identification of compounds was performed by spectral library comparing retention times and light absorbance to authenticated standards. Preliminary results indicated that total phenolic content was higher in thermal and HHP samples than unprocessed controls.

### S11.059

#### Optimising Pomace Production for its Valorisation as a Source of Fibers and Phenolics

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There is currently a renewed interest in the use of fruit pomace as a source of nutritional and functional components. Indeed, fruit pomaces have proved to be valuable sources of fibers and secondary metabolites such as phenolics or carotenoids. These molecules present both antioxidant and colouring properties that can be used in food products as replacement of more conventional, synthetic molecules. Within ISAFruit project, we have optimised the extraction procedures, notably for polyphenols from red fruits. We have also studied the variability in fibers and phenolics, between varieties, from year to year and between processes, so as to conceive an integrated chain which will aim not at production of juice and valorisation of co-products, but at an integral "cracking" of the fruit, as has been done in the milk industry. Work has been carried out on apples and on red fruits: black currants, sour cherries and plums, concurrently with the workpackage dedicated to optimisation of juice production. This presentation will deal specifically with the variability of the fibers and phenolic quality as a function of process prior to extraction. We have seen that the amounts and even more the quality of the fibers and phenolics depend on how the pomace was produced. The existing processes have been optimised for juice production, not for pomace use. Our aim was thus to establish which factors, during the extraction of the juice or pomace stabilization, have major impact on the functional properties of the fibers and phenolics. This will allow us to propose alternatives leading to the most usable pomace material. Focus will be on drying of pomace, with major impact on phenolic composition, and enzyming of the fruit mash, with consequences for fiber quality.

## S11.060

### Alternative Processing Technologies for Fruit Processing

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Actually, consumers demand for more “fresh appearing”, more convenient and healthier fruits products. At the same time fruit industry and packinghouses look for fast and convenient technologies to decontaminate fruit products minimizing losses of nutritional and sensorial parameters. In the frame of the European program ISAFRUIT ([www.isafruit.org](http://www.isafruit.org)) different studies have been undertaken on peaches and apples to answer this demand. The technologies proposed are the microwave pasteurization, the radiofrequency decontamination and the High pressure processing (HPP), which permit a non-thermal pasteurization of food products. Research conducted during ISAFRUIT at IRTA has given the tools and key points that have to be assessed to design a successful protocol at laboratory scale and at Industrial scale to meet the safety, nutritional and sensorial issues. All the technologies have fulfilled the objective to have a medium shelf life between 15 and 30 days. On the nutritional and sensorial aspects, good results have been obtained in peaches and in some apple cultivars, but more work must be done on the vitamins retention during shelf life and sensorial characterization during storage. In summary for microwave processing the final user, the packaging design and the sample geometry can be considered as “ingredients” like the apple cultivar, the composition in sugar and so on. For HPP processing the correct selection of cultivars has to be done in accordance with the application, because most of the undesirable effects occur during the processing.

## S11.061

### Added Value Innovative Fruit Products

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A primary objective of the MP-Fruit work package of the Isafruit project was the development of added value fruit products aimed at consumers who are demanding healthy, safe and convenient foods. To this end we have developed a new generation of fresh cut fruit salads and ready-desserts. The products were developed in collaboration with an SME partner and are based around the addition of functional ingredients including pre and probiotics. In particular, the probiotic micro-organism *Lactobacillus rhamnosus* (GG; LG) and a prebiotic, dietary fibre and sweetener were successfully applied to fresh cut apple. To ensure the safety of the products the efficacy of number of processing technologies including microwave, radiofrequency and sous-vide were examined. In addition, alternatives to sodium hypochlorite the agent currently used for reducing food borne pathogens in minimally processed fresh cut produce were examined with hydrogen peroxide and peracetic acid emerging as good candidates. A range of third generation apple desserts (purees) were also developed and these products have good physicochemical and sensory properties and are now ready for commercialisation. These products were processed by non-thermal (high hydrostatic pressure processing) and thermal (sous-vide processing) strategies and both methods were effective in reducing the natural microbiota of apple purée and gave a shelf-life of at least 21 days is achieved from the microbiological point of view.

## S11.062

### Blackcurrant Nectars - Technology and Quality

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Blackcurrant (*Ribers nigrum* L.) is a very valuable red fruit due to the content of various bioactive compounds having health beneficial properties. These compounds have been proven to protect from diseases of modern civilization like tumour, cardiovascular diseases or obesity. It is very important to increase intake of blackcurrant products by making them more attractive and available during the whole year for consumers. The experiment was divided into two stages. The aim of the 1st stage was optimization of technology for production clear and cloudy blackcurrant juices on laboratory scale. The major concern was the increase of product cloudiness and its stability which primarily depends on the content of the pectic substances occurring in large amounts in blackcurrant fruit. For this purpose different technological parameters were investigated: specific enzymes (polygalacturonase, pectin lyase and macerating combination), enzyme doses, and enzymation times. The best combinations for clear and cloudy juices production were used at the second stage conducted on semi-technological scale to determine the effect of blackcurrant cultivars and technology on nectars quality and the content of bioactive compounds during storage. Three cultivars of blackcurrant ‘Tisel’, ‘Tiben’ and ‘Ben Lomond’ were studied. Using single enzyme, either polygalacturonase or pectin lyase did not allow obtaining juices with high enough turbidity, however macerating combination allowed to obtain cloudy juice with the turbidity of at least 230 NTU. Polygalacturonase allowed to obtain the best pressing-yield so it was applied for clear juice production. Cloudy nectars are characterized by higher concentration of soluble fibre (in case of ‘Tiben’ cultivar 3 times more), phenolic compounds and higher antioxidant activity (17%–37%) compared to clear nectars. Considering quality of the final products the best results were obtained with ‘Ben Lomond’ cultivar.

## S11.063

### Extraction of Flavonols from Apple Skin

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The flavonols are compounds with high antioxidant capacity. In the apple, they are concentrated in the epidermis (360µg/g fresh weight) and they are not extracted during the pressing of the mash to obtain the juice. Methods for extracting generally use the extraction by solvents. The work objective was to seek a greener method for extracting flavonols. The epidermis was rid of all parenchyma cells by enzymatic maceration using endo-polygalacturonase. The composition of the cell wall of epidermal cells was determined to develop a preparation for the enzymatic hydrolysis. The mass of Alcohol Insoluble Substances (an estimate of the amount of cell wall) was reduced from 30 to 40 % after 6 h of hydrolysis depending on the composition of the enzyme cocktail. Although the enzymes were active, the diffusion rate of flavonols in the middle was not improved. Furthermore, the presence of arabinosidase in the enzyme cocktail resulted in the disappearance of avicularine and an increase of quercetin in the supernatant. The solubility of quercetin glycosides did not justify the low amount of recovered flavonols in the supernatant (6 to 8% of total flavonols) in our conditions (liquid / solid ratio of 10). To improve the diffusion we have caused the electropemabilisation of membranes by pulsed electric fields. We processed the epidermis of apple with electric fields up to 20 kV/cm and different times in only distilled water and without any enzymes. The higher the electric field, the greater the extraction rate was. An appropriate electrical treatment can extract up to 40% of polyphenols present in the epidermis.

## S11.200

### Situational Differences in Consumers' Evaluation of Product Benefits

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Product choice is not only determined by the characteristics of the product itself



and the individuals who are intended to use the product, but also by the situation (Belk, 1975; Bloch and Richins, 1983; Rozin, 2007; Meiselman, 2007). This study aims to identify the role of situations in consumers' evaluation of product benefits. A cross-cultural study was carried out in Spain (n=494), The Netherlands (n=560), Poland, (n=514) and Greece (n=515). Respondents rated the importance of product benefits (Health, Convenience, Safety, Emotions, Taste and Satiety) in three different situations (i.e., at home, at work/school and on the move) for two different consumption moments (i.e., snack or main meal). The results reveal that the importance of product benefits differs across the situations and consumption moments ( $p < 0.00$ ). In general, the results reveal that at home Health is more important and out of home (work/school and on the move) Convenience and Satiety are more important. More specific, at home having a main meal consumers attach more importance to Health, Safety, Emotions and Taste compared to the other situations and less importance to Convenience. For the consumption of snacks on the move Convenience and Satiety are very important compared to the other situations. Health, Emotions and Safety seem to be the least relevant while having a snack on the move. Convenience and Health are not very important while having a main meal at work/school, in these situation consumers attach relatively high importance to Taste and Satiety. The role of situations will be extended by investigating the differences in consumers' product preferences across situations. The preliminary results reveal that the evaluation of product benefits differs across situations. Therefore, it might be promising to apply situation-specific strategies for both fruit promotion campaigns and consumer-driven product development.

### S11.201

#### Should we Take a Sourpuss and Someone who Has a Sweet Tooth with a Grain of Salt? Fruit Consumption and Basic Taste Preferences

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There is a growing concern that the dietary patterns of Western societies need improvement (Allen *et al.* 2008). To increase healthy food consumption it is important to have insight in consumers' consumption and preferences of fruit and other types of snacks. Wansink *et al.* (2006) present the 'sweet tooth' hypothesis, which implies that people who consume more sweet snacks also consume more fruit. The aim of this study was to better understand how fruit consumption is determined by means of exploring the relationship between the consumption of different types of snacks and consumers' basic taste preference (sweet, salty and sour). In total, 2083 respondents from Poland, Greece, Spain and the Netherlands filled in an online questionnaire in which consumption of fresh fruit, sweet snacks, salty snacks, freshly squeezed orange juice and dried fruit was measured. 29% of the total sample preferred a salty taste, 21,5% preferred sweet and 10,5% preferred a sour taste, 39 % did not prefer a specific taste. We found that people who prefer sweet taste consume more chocolate bars, people who prefer salty taste consume more crisps and people who prefer sour consume more apples, peaches, orange juice and dried fruit. In addition, consumers who prefer a sweet taste health as a product characteristic is more important compared to sour preferring consumers. In addition, salt and sweet preferring consumers show a higher importance of taste. In contrast with what was expected that sweet preferring people consume more fruits, our study shows that the sour preferring group consume more fruits and fruit products. Taste might be an interesting characteristic to take into consideration while the sweet and salt preferring consumers say taste is more important to them than the sour preferring consumers. Our present findings may have implications for promotion activities to increase healthy fruit consumption.

### S11.202

#### Apple Preference Mapping France

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To gain insight into the taste preferences of consumers, a European study was launched in 2007 to map consumer preferences for apple in connection with the

Isafruit project. Eleven apples cultivars were tested. The main study revealed that consumers can be segmented into two main groups. One group (69% of consumers) prefers sweet apples with a fruity flavour. The other group (31%) showed a preference for tart, firm apples. Based on tests carried out on 660 French consumers (South-west region and Paris area) and on sensory analysis from a trained panel of the Ctifl centre of Lanxade, a preferences map for France was obtained using the SenSominer software (confidence ellipse, cluster dendogram and mapping). These results provide valuable information to operators in the sector in terms of the choice of varieties and communication strategy. In the longer term, programmes aimed at developing new varieties can be geared to the gustatory preferences of consumers.

### S11.203

#### Peach Fruits Consumption in Poland - Consumer Preferences Towards New Cultivars

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Poland is not important producer of peach and nectarine. Old cultivars only, suitable for our climatic condition, are grown in some parts of the country, so the consumption of peaches and nectarines is rather seasonal and consumers experience is based mainly on taste of old cultivars. It was interesting to check out the reaction of Polish consumers on fruits of new peach and nectarine cultivars grown at southern European countries. The experiment was done within the confines of the ISAFRUIT project, where the consumers' appreciation of new cultivars of peach and nectarine were investigated. The pooled group consisted of 100 Polish respondents; male (50%) and female (50%), between 15 and 70 years old. First respondents completed a questionnaire concerning their peach and nectarine consumption habit. Further each of them evaluated taste and appearance of 12 cultivars in 9-points hedonic scale. The results showed that the gender and the age group influenced on peach consumption habits. Women declared higher peach consumption (3.0) compared with man (2.7). Additionally more males than females admitted to consuming peaches and nectarines occasionally. The peach consumption changed with the age of respondents with the tendency of higher peach consumption by older groups. With regards to the fruits appearance, there was found that nectarines cultivars was more accepted than peaches. Yellow flash peach and nectarine were more appreciated compared to white flash ones, whereas the cultivars without typical shape for peaches (flat) were less accepted. Taking into consideration the taste it may be concluded that regardless the appearance, all cultivars with very firm flash received the lowest score. The data indicated that Polish consumers preferred fruits with sweet soft yellow flash as well as they more appreciated nectarines to peaches. They declared increased peach consumption when new cultivars become available on the Polish market.

### S11.204

#### Exploring Consumer Preferences of Apples in Switzerland

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Consumer acceptance of high-quality apple varieties to increase fruit consumption was investigated within WP 6.3 in ISAFRUIT, a European project in Framework "6". A subset of European data has been evaluated to ascertain the preferences of Swiss consumers and to compare these with the European Results. 11 varieties have been tested for their acceptance with 550 Swiss consumers in 2 different locations. The data acquisition of flavor and appearance liking was supplemented by the descriptive evaluation of the varieties by a trained sensory panel (n=12). Preference Mapping has been used to link the data sets and identify preferences based on certain sensory apple characteristics. New varieties have shown significantly higher acceptance ratings than the traditional varieties Golden Delicious and Jonagold. When comparing mean ratings of Swiss consumers with the results of European consumers almost no differences in liking could be found. Swiss consumers differ in their preferences for the tested varieties. Evaluation of the data has shown

3 clusters of about the same size. Consumers in one cluster prefer sweet to rather acidic, aromatic and crisp apples with a firm fruit flesh. This consumer group tolerates a slightly lower fineness of the fruit flesh. A second group of consumers prefers sweeter, fruity and aromatic apples, partially with a floral aroma and a higher fineness of the texture, whereas they are less demanding on firmness. The preferences of the third group are located in between the two other clusters. All consumers share the rejection of soft and mealy apples and a tendency to a grassy aroma as well as a low aroma intensity.

### S11.205

#### Italian Consumers Preferences According to Peach Fruit Organoleptic Characteristics

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A consumer test on peach hedonic evaluation has been conducted in Bologna, Italy, in the framework of the European project ISAFRUIT (Increasing Fruit consumption through a transdisciplinary approach leading to High quality produce from environmentally safe, sustainable methods). Ten cultivars, were selected as representative of the mid-season production, of fruit types (peach, nectarine, cling-stone, flat), flesh colour (white or yellow) and texture (melting or not-melting), and taste (acid, subacid, well-balanced). One hundred consumers were involved in fruit evaluation according to a protocol defined by ISAFRUIT partners. All fruits were harvested and stored following the same methodology in Italy (Alirosada, Caldesi 2010), Francea (Royal Lee, Opale) and Spain ("Nectaperle", "Sweet Cap", "Mountain Gold", "Nectareine" e "Nectaross"). For "Nectareine" and "Nectaross" a comparison about the effect of ripening stage at harvest on fruit acceptance was also performed. All cultivars reached at least a medium level of acceptability for taste (5 on 9). However, large difference were recorded, with the subacid peach "Royal Lee" getting an evaluation just over the acceptability threshold, while other cultivars, in particular "Nectaperle" "Sweet Cap" and "Caldesi 2010", recording high scores. The subacid nectarine "Nectareine" had the higher evaluation when harvested at the earlier ripening stage, the opposite was recorded for "Nectaross". As related to appearance the highest evaluation was recorded by "Nectareine" and by the cling-stone "Mountain Gold". For some cultivars the good evaluation for appearance was not confirmed by liking degree at consumption.

### S11.206

#### Consumer Preference Mapping for Apple Cultivars across Different Spanish Regions

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In Spain, low apple consumption is mainly due to the lack of consumer's expectations by market supply. One way to increase it could be by providing cultivars with new sensory attributes and higher overall quality. In this work we studied the influence of cultivar (traditional and new) over consumer preferences from several regions of Spain. On the basis of the European project ISAFRUIT, external preference mapping combining sensory analysis based on trained panel evaluation of 11 apple cultivars ('Pink Lady', 'Goldchief', 'Rubens', 'Fuji', 'Golden Delicious', 'Junami', 'Ariane', 'Kanzi', 'Wellant', 'Ligol' and 'Jonagold'), merged with data of instrumental quality and acceptance data from the consumer test was carried out. Apple consumer tests involved 880 consumers from five regions of Spain: Catalonia, Aragón, Basc Country, Comunidad de Valencia, Comunidad de Madrid, and were developed during January and February 2007. Consumers were classified in 6 different clusters, which were in turn were grouped in 2 megaclusters of similar characteristics. The first megacluster included 4 clusters and reunites 68% of the

consumers, ranging from 64% (Catalonia, Girona city) to 84% (Aragón, Zaragoza city). This group of consumers (3 clusters) preferred sweet apples with mid range acidity apples or low acidity apples. Consumers in the second megacluster (2 clusters), grouped 32 % of the consumers, ranging from 16% (Aragón, Zaragoza city) to 36% (Catalonia, Girona city) and their preference is based in high acidity and juicy apples with mid range values for sweetness. The different clusters are practically independent of age and gender. Increase fruit consumption of apples can be achieved when the consumers are offered the varieties corresponding to their preferences.

### S11.207

#### Consumer Preferences in Fruit Juices. Heinz Sunshine Case Study

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Tomato is a vegetable of great economic importance in Spain. The drink "Heinz Sunshine", developed by Heinz Tomato Company, combines different fruits and tomato. It is born to respond to the necessity of a healthy life together with short time for food preparation. The fruits contained in Sunshine serve as a supplement contributing to the recommended daily intake of vegetable products to get a healthy diet. The present work includes a scientific consultant ship process - technical postproduction of the juices of fruits with tomato, materialized in the elaboration of materials to use in the launch of the product, helps for the elaboration and interpretation of the data of fruit juices consumption. The consumers study carried out in 4.000 homes in Spain, demonstrates that the main reasons for a low intake of fruit are the lack of time and habit, especially in the case of the professionals between 30 and 64 years. The study also shows that the tomato is present in half of the purchase-baskets and it is one of the fruits preferred by the Spaniards (90%), proceeded by the orange, the apple, the banana and the pear. The concern of a healthy diet rich in fruits increases with the age and also when the families go growing. The interest of higher fruit consumption is about 38% for couples without children, and 64.1% for those with 3 or more children. The report also reflects that 100% of the Spaniards knows the benefits of fruits intake for the organism, and 33% recognizes that they their daily intake is not enough; among them, 82% substitutes the fresh fruit for juices.

### S11.208

#### Prediction of Novel Product Acceptance Based on Comparison of Intentional and Actual Consumers' Behaviour

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The new attractive dried fruit products of high nutritional value have been developed within the ISAFRUIT project. To ensure product appreciation by the consumers the survey was carried out at the first stage of product development, and the following consumers' claims were identified. Raisins and muesli were declared as the most popular and readily consumed dried fruit products. Consumers would like to consume dried fruit with functional properties, preferably of antioxidant potential. Moreover, the consumers' inclination to products with high content of fruit component was indicated. Once the new products were developed the special semi-consumer test was set up to gather data for preparation of a promotion campaign. The research was performed among 58 citizens of Skierniewice, Poland. Initially the respondents were asked to answer a few questions concerning their consumption preferences towards dried fruit products. Further they evaluated osmo-convectively dried sour cherries (the best product obtained within the ISAFRUIT project) and raisins individually, and then with added cereals. Moreover the respondents were encouraged to express their opinion about the advantages and disadvantages of the evaluated products. The results of the first part of the questionnaire confirmed that raisins and breakfast cereals are the most popular among dried fruit products. With regards to actual perception of real fruit, higher appreciation of osmo-convectively dried sour cherries than raisins indicates that they can compete with the dried fruit

commonly present on the market. Also dried sour cherries added to cereals seem to have a chance to be adopted as muesli components. Their refreshing and balanced taste should be emphasized as the product merits.

## S11.209

### Attributes Influencing Consumer Preference for Apple Cultivars

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Apples are considered to be a part of a healthy diet. While health is a motivating factor for purchasing fruit, there are many reasons why a high proportion of people do not meet recommended daily intakes. Besides fruit qualities, these include socioeconomic and social factors in the major part. The aim of this study was to examine apple cultivar preference of consumers and gather information on all the attributes that might influence consumer preference for apple cultivars. The taste testing included 13 cultivars (Autumn Crisp, Crimson Crisp, Fuji, Gala, Golden Delicious, Golden Russet, GoldRush, Granny Smith, Honeycrisp, Pixie Crunch, Red Delicious, Suncrip, Sundance) and involved 757 people in total representing a wide range of social/educational levels. By the taste testing, consumers were asked to rate the importance of twelve attributes named on the questionnaire (appearance, taste, cultivar name, origin, production method, growing area, sales place, price, advertisement, package size, labeling and season). Based on the preference ratings given, Honeycrisp, Crimson Crisp, Sundance and Suncrip were the most liked apple cultivars showing how important the texture by cultivar preference. In accordance with results of previous studies, fruit qualities seemed to be the major attributes drive the choice of apple cultivars regardless of the age and gender. It is also concluded that the degree of liking of a particular cultivar varies through profession and annual income. The questionnaire completed as a part of this consumer study collected data on the consumers, their attitudes and their eating and purchasing habits, thereby providing useful background information for apple breeding and marketing strategy.

## S11.210

### Apple and Peach Consumption Habits across European Countries

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The aim of this study was to gain information concerning apple and peach consumption frequency within European countries in relation to age and gender. The survey was a part of a complex experiment with the aim of evaluating consumers' preferences towards new varieties, and the data is based on the self-reported declarations of respondents, male and female, between 15 and 70 years old. 4271 consumers from 7 European countries were invited to supply information about apple consumption habits, whereas 499 respondents from 5 countries answered questions relating to frequency of peach and nectarine consumption. In both, the apple and the peach surveys, data analysis of declared intake showed significant differences between nationalities. The highest apple consumption was in Poland, where over 55% declared a consumption of more than 5 apples per week. In comparison, Italian consumers indicated eating 3-5 apples per week (39.3%). The lowest apple consumption was in the Netherlands and Spain. In the case of peaches, the highest

consumption was indicated in France where over 80% of respondents declared they eat at least 3-5 peaches per week. The lowest peach intake was declared in Germany. Irrespective of country women were shown to eat more apples than men. Furthermore, the group of older people (61-70 years) consumes apples more often than the adult group (36-60), while within the youngest group (15-35) eating apples was not popular at all. Females declared a higher peach consumption, and again significantly lower fruit consumption by the youngest group was indicated. Although fruit availability remains a prime factor in determining apple and peach consumption, a targeted informational campaign showing the beneficial effect of fruit consumption on human health seems to be necessary for promoting higher fruit consumption, especially among male European citizens and the younger generation.

## S11.211

### Dried Sour Cherries and Blackcurrants - Is it Promising Snack for European Consumers?

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Sour cherries and blackcurrants may be a source of nutritional compounds influencing positively human health. However, they are rather not preferred by consumers because of astringent taste. To increase their attractiveness the Dehydration-Immersion by Soaking (DIS) was applied as a pre-treatment as it offers simultaneous enhancement of sensory quality and opportunities to fortify the structural matrix of fruit tissues with health-promoting compounds. After convective drying, the osmo-treated fruits become similar to raisins and can be consumed as ready-to-eat snacks. After many technological trials, four products – two of sour cherries and two of blackcurrants, with different tastes (sweet and sweetly-acid) – were chosen as the most promising. To assess their chances on the market, a consumers' test was performed among 289 respondents from France, the Netherlands and Poland. The samples were evaluated on a 9-point hedonic rating scale, and the respondents were encouraged to express their opinion about the advantages and disadvantages of the tested products. Along with consumers' evaluation, the products were assessed by profiling method. The sensory map has been prepared to compare the consumers' preferences with the products' quality characteristic. Irrespective of the country, the dried sour cherries were significantly more appreciated than blackcurrant products. Further, sour cherries of sweetly-sour taste profile were higher ranked than the sweet ones. In the case of blackcurrants, the sweeter product was more desired. Apart from well balanced taste, the high evaluation of sour cherries with sweetly-acid taste profile was explained by a tender texture (which was not the case for blackcurrant products) and an appealing glossiness of sample's surface. Although the appreciation level of particular products varied between countries and age groups, the unequivocal highest scores for sweetly-acid dried sour cherries indicate that this kind of fruit snack might be successful on the European market.

## S11.212

### Improving Appeal and Nutritional Value of Processed Fruit Taking into Consideration Driving Forces of the Market

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The fruit processing industry must compete with the other food production sectors, e.g. juice/fruit drinks and mineral water industries. Planning activity within the processing pillar of the ISAFRUIT project took driving forces of the market development into consideration. For developing new products, factors appealing to senses

and internal quality factors were taken into consideration. Recommendations for the fruit processing industry were given in the following areas: minimally processed fruit; dried fruit; cloudy juices technology. Novel products (one of the major driving force) developed by the ISAFRUIT team were: minimally processed fruit products containing probiotic bacteria; fresh cut salads and ready-desserts; flexi and crunchy dried snacks (some having functional properties); direct cloudy juices or nectars made from plums (technology tested at an SME plant) and blackcurrants. Utilization of pomace for production of value added products was also intensively exploited. To investigate acceptance of the market, consumer tests of some products were carried out to find out preferences of potential clients. Considering good image of the products (another driving force of the market), safety of fresh-cut and fruit deserts was also studied. To increase consumers' confidence, analytical data were collected for use in authenticity control of products, particularly juices obtained from scab-resistant cultivars. Fresh fruit and processed fractions, with known physico-chemical properties, were supplied as nutraceuticals for animal and human studies carried out in ISAFRUIT pillar 2. This pillar is studying health effects and is collecting health-related information to use in further promotion of fruit and fruit products in the diet.

### S11.213

#### Metabolite Profiling in the Diet, Cancer and Health Cohort - With Focus on Fruit and Vegetable Intake

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It is hypothesized that a diet rich in fruits and vegetables is associated with a lower risk of chronic disease, and that a person with such a diet presumably displays metabolites in plasma related to this habit. It is envisioned that advanced exploratory metabolite screening tools will provide many new useful insights into biomarkers for recent as well as habitual intakes of various foods and their possible relation to disease development. The aim of the present study was to investigate metabolites related to fruit and vegetable intake through metabolite profiling of plasma samples from participants in the Danish Diet, Cancer and Health (DCH) cohort study. The present case-cohort study includes 350 women from the DCH cohort study, of which 175 developed colon cancer and 175 were references. The cohort consists in total of 57,053 men and women free of cancer at baseline (1993-1997) for whom data on lifestyle and dietary factors were collected at recruitment. Furthermore, non-fasting blood samples (30 ml) were drawn from each participant, and the samples were spun and divided into fractions. All samples were processed and frozen within 2 hours at -20 °C and transferred to liquid nitrogen vapor (max. -150 °C). For this study, the plasma fraction was used for analysis. Liquid Chromatography-Mass Spectrometry (LC-MS) metabolite profiling was performed on all samples, and data was processed and aligned using Markerlynx software. Patterns associating the measured metabolites with dietary markers of fruit and vegetable intake or with subsequent disease outcome are currently being explored by multivariate chemometric methods in Matlab. Data analysis is currently ongoing, and preliminary results are promising, indicating several markers that can effectively discriminate between persons in the study population. Final results will be ready for the conference.

### S11.214

#### Levels of Some Trace Element in Dry and Fresh Fruit Samples of 9 Apricot Cultivars

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Trace elements play an important role in the metabolic pathways during the growth

and development of plants, when available in appreciable concentration. concentration of Boron(B), Cobalt (Co), Copper (Cu), Chromium (Cr), Iron (Fe), Magnesium (Mg), Manganese (Mn), Molybdenum (Mo), Nickel (Ni), Selenium (Se), Strontium (Sr) and Zinc (Zn) was analyzed using Inductively coupled plasma-atomic emission spectroscopy. Fresh and dry fruit samples of "Jumbo cot", "Tom cot", "Gold strike", "Gold bar", "Bergeron", "Bergarouge", "Sweet cot", "Yellow cot" and "Zebra" apricot cultivars were analyzed. The results were in the range of 3.43- 40.4 mg/kg for Boron, 0.028- 0.07 mg/kg for Co, 0.065-0.263 mg/kg for Cu, 0.66-6.42 mg/kg for Cr, 3.11-19.3 mg/kg for Fe, 85.1-648 mg/kg for Mg, 1.15-10.2 mg/kg for Mn, 0.08-0.2 mg/kg for Mo, 0.11-2.19 mg/kg for Ni, 0.32-0.8 mg/kg for Se, 0.14- 2.67 mg/kg for Sr and 1.07-10.02 mg/kg for Zinc. B, Cu, Fe and Zn in "Tom cot" were significantly higher than other cultivars. "Jumbo cot" has the highest content of Cr. In Gold strike" and "Zebra" Sr was about 2.60 witch was significantly more than others. Also in "Zebra" and "Sweet cot" Mn content was significantly higher.

### S11.215

#### Hazardous Element Content and Consumption Risk of 9 Apricot Cultivars

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The heavy metals pollution is one of the problems that arise due to the increased uses of fertilizers and other chemicals to meet the higher demands of food production for human consumption. In order to assess possible health risk of apricot consumption, levels of Arsenic, Cadmium, Mercury and Lead was determined in fresh and dried samples of "Jumbo cot", "Tom cot", "Gold strike", "Gold bar", "Bergeron", "Bergarouge", "Sweet cot", "Yellow cot" and "Zebra" apricot cultivars. Wet digestion of samples with concentrate HNO<sub>3</sub> - H<sub>2</sub>O<sub>2</sub> digester mixture and inductively coupled plasma-atomic emission spectroscopy was used. Highest content of As, Cd, Hg and Pb among all cultivars, was 0.5, 0.04, 1.5 and 0.5mg/kg of dried apricot samples. Fresh fruit samples also contain 0.2, 0.016, 0.6 and 0.2 of Arsenic, Cadmium, Mercury and Lead respectively. Daily intake of metals, hazard quotient and health risk index to reveal health risk possibility of dried and fresh fruits consumption will discuss in this paper.

### S11.216

#### The Influence of Different Apple Based Supplements on the Intestinal Microbiota of Humans

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The present project is part of the large ISAFRUIT project, where one of the objectives is to identify effects of apple and apple product on parameters related to gut health. In a previous rat study we observed changes in the intestinal microbiota of rats fed whole apples, pomace or apple pectin ([1], and we were interested in finding out if the same effect can be observed in humans. The study was conducted as a randomized, controlled 5 x 28 days cross-over study with 24 healthy persons of both genders. The persons were following a pectin- and polyphenol free restriction diet during the control period, and in the four other periods it was supplied with four different apple based supplements. Between the diets there was a 2-week wash-out period still on the restriction diet. The four apple based supplements were: 1) whole apples, 2) clear apple juice (pectin-free), 3) cloudy juice (apple juice with pulp), and 4) pomace (press cake from the cloudy juice production process). Fecal samples were taken before and after each diet period. After DNA extraction,

Denaturing Gradient Gel Electrophoresis (DGGE) with universal primers and specific primers for bifidobacteria and Clostridium cluster XIVa was performed. Bands differing between the periods were sequenced, and qPCR was performed to verify the changes observed by DGGE. Changes in the microbiota was observed by DGGE in persons consuming whole apples and pomace. In contrast, the two juice supplements did not show any effect on the microbiota by DGGE. Consumption of whole apples or pomace is able to modify the intestinal microbiota of humans.

### S11.217

#### Composition and Activity of the Intestinal Microbiota and Metabolite Production when Feeding Rats with Specific Apple Components

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We have shown previously that the caecal microbiota is altered in rats fed with whole apples and with apple pectin [1], but the local and systemic consequences of this change are unknown. We therefore wanted to link chemical profiles of urine and faecal samples with profiles of the microbiota to find relationships between the growth of bacteria (specific or groups) and changes in concentration for specific metabolites. Chemical profiles were recorded using LC-QTOF-MS of urine and of the aqueous phase of faeces to obtain approximately 5000 substance-related features each in positive and negative mode. We used DGGE of the gene for 16S RNA to profile approximately 40 bacterial strains. Links between the two data sets were explored using multivariate data handling methods (i.e. chemometrics) both in data pre-processing and modelling. *Clostridiales* and *Bacteroides* were inversely related with each other. Specific patterns in the chemical profiles were apparently strongly related to the alterations in these strains. A prediction model for the change was built and validated based on the chemical profiles. The urine profile was most predictive for the caecal change in the microbiota. Distinct changes in the gut microbiota can be recorded after intake of fruit and pectin and these changes have consequences for the chemical environment locally as well as systemically. The altered gut microbiota is predicted more strongly by the chemical composition of urine than by that of the faeces.

### S11.218

#### Effects on the Transcriptome in Apple Fed Rats

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Increased consumption of fruit has been associated with improved health and well-being. Apples are one of the most frequent consumed fruits in Europe and a prime source of fibres. Furthermore, apples contain a variety of bioactive compounds. The constituents in apples may interact with genes and cause changes in the gene expression. The aim of this study was to investigate the effect of unprocessed apple on the rat transcriptome in order to identify target activated pathways and further explore the health beneficial mechanisms of action. Using DNA microarray technology, with thousands of genes examined in a single hybridization, gene expression profiles of apple fed rats (10 g/d) were identified and compared to expression profiles of controls. Gene Set Enrichment Analysis (GSEA) was used for extracting biological insight from gene expression data sampled from colon and liver. GSEA, focusing on gene sets or groups of genes that share common biological function or regulation, showed changes in the transcriptome of apple fed rats. The effect is moderate but extensive and includes several cellular and metabolic processes. The health beneficial effects of apple may be ascribed to changes in the biosynthesis and transport of cholesterol and bile acid as well as the glutathione metabolism. Furthermore, genes involved in these affected pathways are currently being validated by quantitative real time polymerase chain reaction (qPCR).

### S11.219

#### Physical Properties and Antioxidant Activity of Plum Fibre

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High content of dietary fibre and antioxidants makes plums an important component of a healthy diet. The intake of fresh plum fruits with a diet in Poland is relatively low because of short market availability. Plum fruits are consumed fresh or processed to compotes, jams, marmalades, dried fruits, juices and alcohol beverages. Mild laxative effect & decrease of blood cholesterol are attributed to plums. Plum fruits (*Prunus domestica* L.) of three cultivars 'Promis', 'Najbolja' and 'Dąbrowicka' were collected at picking maturity at the Research Institute of Pomology and Floriculture, Poland, in 2007 and 2008 season to be used in laboratory scale & also in pilot plant scale juice production in RIPF. Industrial trials in Alpex were conducted on plums available at the market. Swelling and water binding capacity (WBC) of fresh fruit and pomaces were measured. Swelling of plum fruit were 2 times higher than of pomaces. Lower values for pomaces were correlated with lower than in fruits share of soluble dietary fibre in total dietary fibre. Swelling of plum pomaces was lower than swelling of black currant pomaces and comparable with swelling of cherry pomaces. WBC of plum fruits depends on cultivar with 'Promis' expressing the highest value. WBC of plum pomaces were decreased comparing to fruits. WBC of 'Najbolja' and 'Promis' pomaces were higher than of 'Dąbrowicka'. Hydration properties of pomaces obtained in industrial trials were reduced comparing to pomaces obtained in pilot plant scale. Antioxidant capacities of plum pomaces were comparable with apple pomaces but 10 times lower than black currant pomaces. It was proven that plum pomaces characterized by sufficient hydration properties and sufficient antioxidant activity have interesting functionality.

### S11.220

#### Use of Persimmon Excess for the Elaboration of Healthy Seasonings

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Nowadays, the interest of the consumer about health benefits of the food it is getting more and more important, so that is the reason why research in this area have increased in recent years. Moreover, people are demanding added-value products with new characteristics. Several studies have shown a negative correlation between the consumption of fruits and vegetables and some health problems (Willett W.C., 2001). It is considered that the main responsible of these healthy properties are the amount of antioxidant including vitamins, phenolic compounds and carotenoids contained in this fruit. Each year in Spain, a big part of the harvest of every fruit is rejected because of the weight, deformations or overproduction. One of the aims of this work is the use of these excess fruit to elaborate new seasonings. Persimmon was one of the selected fruits, which shows several health benefits related to the phenolics content (Yokosawa.T & Okumura.F., 2007). We produced a seasoning from persimmon fruit by double fermentation process (alcoholic and acetic fermentation). We optimised an extraction method and then we measure the antioxidant capacity (ORAC and DPPH) and Total Phenolics Index (TPI) in the fruit puree, wine and seasoning samples to evaluate the evolution of these parameters during elaboration. The antioxidant capacity from the fruit to the final seasoning was constant except for the ORAC assay which had an important decrease before the acetification. Finally, the values obtained for our condiments were compared with some commercial vinegars. The antioxidant capacity of the final seasonings was higher than other commercial vinegars like white and red wine vinegars. These results make persimmon seasoning an interesting healthy product competent in the commercial market.

### S11.221

#### Effect of Apple Products on Blood Lipids in Laboratory Animals

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A variety of positive effects on human health have been associated with the ingestion of fruits and vegetables. Regular consumption of fruits and vegetables is associated with reduced risks of certain cancers, cardiovascular diseases, stroke, etc. In this presentation, we will focus on apples which are the most highly consumed fruits in northern parts of Europe and how it influence markers of cardiovascular disease. We have investigated whether apple pomace, a by-product from the food industry, could possess preventive properties against cardiovascular risk markers in the transgenic Ldlr mice. In the study 16 male and 16 female mice were randomised in two groups. During the three-week acclimatisation period all animals were fed a commercial chow diet. In the study period mice in group 1 were given a purified control diet and mice in group 2 were given a purified diet with 6.5% apple pomace. All mice were in addition fed 0.3% cholesterol incorporated in the feed. Levels of triglycerides and cholesterol in plasma were measured several times during the study. After 19 weeks all mice were sacrificed and the aorta taken out for evaluation of area covered by plaque. Plasma levels of the lipid fraction HDL, LDL and VLDL were analysed. The animal experiment was carried out under the supervision of the Danish National Agency for Protection of Experimental Animals. Transgenic mice given apple pomace in the feed showed no overall difference in plasma total triglycerides and cholesterol compared to the control group. Addition of apple pomace to the feed seems to have a slight effect on the level LDL and HDL.

### S11.222

#### Food, Health and the Consumer: The Key Role of Fruit and Vegetables

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Food, health and the consumer are best depicted as a triangle which accommodates the three-way interaction between them. Fruit and vegetables are major players in this triangle in their role as foods, their recognised beneficial effects on health, and as products familiar to consumers world-wide. Firstly, this presentation reviews key nutritional issues and the criteria currently applied for determining the effects of fruit and vegetables and their bioactive components on human health. It traces the origins of 'human nutrition thinking' in terms of (i) primary producers of information; (ii) expert and advisory groups; (iii) food industry & multinationals & promotional agencies; (iv) government departments & agencies (v) WHO, FAO, EFSA, EU-; (vi) media & consumer organisations; (vii) nutrition education. The concepts of inherent functionality and natural complexity in fruits and vegetables are discussed in the light of obesity and the rapidly expanding field of functional foods. Secondly, food and nutrition policies/advice and dietary guidelines on fruit and vegetables prevailing in different countries are reviewed together with their likely impact on trade and on consumers. Thirdly, the effects of crop production/storage and processing (minimal, intermediate, full scale, novel) methods on the quality and nutritive value of fruit and vegetables, and their products, are reviewed in the context of (i) intensity of crop production; (ii) natural toxicants; (iii) GMO and organic production; (iv) food miles; (v) food labelling; (vi) food safety and risk analysis; and (vii) consumer awareness/education.

### S11.223

#### Composition and Energy Value of Plum Pomace

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Considering that pomace, especially plum pomace, a by-product in juices, has been utilized by the industry to a very small extent the aim of the work was extension of knowledge on composition of polyphenolics and properties of fibre preparations obtained from fruits and their pomaces. Plum fruits and pomaces were analyzed for total, soluble, and insoluble dietary fibre (TDF, SDF, IDF respectively) by AOAC enzymatic methods as well as free soluble sugars and polyphenols. Fruits of plum (*Prunus domestica* L.) of three cultivars 'Promis' (PR), 'Najbolja' (NA) and 'Dąbrowicka' (DA) were collected at picking maturity at the Research Institute of Pomology and Floriculture (RIPF), Poland, in 2007 and 2008 season to be used in laboratory scale & in pilot plant scale in RIPF. Industrial trials in Alpex were conducted on plums available at the market. Lyophilised pomace obtained from plum cultivars during pilot plant cloudy juice production are characterized by over 40% TDF contribution and mean content of carbohydrates reduced by half, comparing to lyophilised fruit. Protein and fat present in fruits are cumulating in pomace as well. That resulted in total 10% content of those nutrients in pomace, with reduced to 1/3 energetic value, comparing to fruits. Proteins in NA and PR pomaces are significantly lower comparing to DA pomace. Fat and ash in all pomaces are c.a. 2% each in all pomaces. It was proved that plum pomaces obtained in laboratory scale, pilot plant scale and industrial trials were characterized by energy value on the level of 220 kcal/100 g and contained from 35 to 50% of total dietary fibre in DM with the share of soluble fraction from 14 to 20%.

### S11.224

#### Industrial Sour Cherry Pomace as a Source of Phenolic Compounds

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Sour cherry pomace is a side product in juice production & is usually used as a fuel. Nevertheless it contains many phytochemicals and carbohydrates. However, there is a possibility to utilize the pomace as a raw material for preparation of the products possessing valuable biological properties i.e. containing dietary fibre and polyphenol extracts. The aim of the research was to identify polyphenol components in stoneless fraction of industrial cherry pomace. Fresh industrial sour cherry pomace after separation of stones was extracted and purified on polymer bed using low pressure liquid chromatography. Three fractions of extracts were obtained, next lyophilized and analyzed by HPLC qualitatively and quantitatively for polyphenols. Two obtained extracts were characterized by high content of polyphenols. Both extracts contained over 10% of polyphenols, with main groups being hydroxycinnamic acids, anthocyanins and other flavonoids, as analyzed by HPLC. Extracts contained anthocyanins: cyanidin glucosyl-rutinoside, and cyanidin rutinoside most of all. Hydroxycinnamic acids which occurred in the extracts were: neochlorogenic acid, chlorogenic acid and two p-coumaroylquinic acids. Moreover, quercetin, kaempferol, isorhamnetin and naringenin glycosides, one dicaffeoylquinic acid and a procyanidin dimmers, trimers, tetramers, pentamers were found in the extracts. Industrial cherry pomace containing various polyphenols is a valuable raw material to obtain concentrated polyphenol and dietary fibre preparations, which could be used as natural food additives.

### S11.225

#### Apple, Cherry and Blackcurrant Increases Nuclear Factor $\kappa$ B Activation in Liver of Transgenic Mice

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Background: NF- $\kappa$ B is essential in normal physiology, and several human disorders

involve inappropriate regulation of NF- $\kappa$ B. Diets dominated by plant-based foods protect against chronic diseases, and several food derived compounds have been identified as promising NF- $\kappa$ B modulators. Objective: To investigate the effects of diets supplemented with apple, blackcurrant or cherries on LPS-induced NF- $\kappa$ B activation *in vivo*. Design: Transgenic NF- $\kappa$ B-luciferase reporter mice were utilized, and both whole body and organ specific NF- $\kappa$ B activities were determined. Mice were randomized into groups receiving lyophilized apple, cherry, or blackcurrant powder supplemented diets, or control diet. The mice had ad libitum access to the respective experimental diets for 7 days. On day 7, all mice were given an LPS-injection, and NF- $\kappa$ B activation was monitored by *in vivo* imaging for 6h. After imaging, blood samples were taken, the mice were sacrificed, and ex vivo imaging of organs was performed. Results: Compared to the control group, the apple and cherry groups had slightly higher whole-body NF- $\kappa$ B activation at 4h, and all three experimental groups had higher NF- $\kappa$ B activation at 6h. LPS-induced NF- $\kappa$ B activation in liver was increased with all three experimental diets but no effects were observed in other organs. Conclusions: Our findings indicate that high intakes of lyophilized fruit powders modulates *in vivo* NF- $\kappa$ B signaling in the liver following LPS-induced stress, however consequences of this NF- $\kappa$ B modulation in hepatic tissue needs further investigation.

### S11.226

#### Methodological Aspects of Fruit Quality Evaluation Using Biospeckles

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When a coherent laser illuminates a material, the scattered light exhibits mutual interference and forms randomly distributed bright and dark spots of variable shapes called speckle pattern. If particles within a biological material are in motion, the speckle pattern exhibits spatial and temporal fluctuations and is said to "boil" or "twinkle". This phenomenon is called biospeckle. Biospeckles are used for investigation of biological objects since 15 years and it was shown in a few papers that the method can be used for characterization of properties and quality aspects of fruit and vegetables. The biospeckle dynamics is interpreted as a motion of intracellular organelles and particles Brownian motion which can be affected by water content. It was stated also that, in the case of fruit and vegetables, biospeckle provides information from the area under the skin since the tissue is transparent for a laser light. Chlorophyll distribution influences depth of light penetration which affects the biospeckle dynamics. Biospeckle method is useful for bruising detection under the skin and for monitoring of ripening process. Although the interesting results were obtained, there are many methodological aspects to be concerned for horticultural products investigation with this method. In this work, a few aspects: lighting and exposure conditions, temperature and sampling place will be discussed. Advantages and disadvantages will be summarised to give a critical view about a potential of the method for practical application for a quality assessment of fruit and vegetables.

### S11.227

#### Evaluation of Y Training System on Growth, Yield and Fruit Quality in Apple Orchards

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This study was carried out for two years consecutively on Apple trees trained in Y training system. We evaluated the effect of Y training system on growth, yield and fruit quality. The experiment conducted in 2008-2009 on a loam soils at the Horticultural research station of the Horticulture department of Tehran University, Iran. We used dwarf rootstocks with the density at 1666 trees/ha. Trees planted in spring 2005 and were drip irrigated. Flower buds were present in the second year after planting. The experiment was carried out on 'Golab kohanz', 'Delbar stival', 'Starking', 'Primerose' and 'Fuji' trees on M9 rootstock and planted in a randomized complete block design (RCBD) with five treatments and four replications. After five years the maximum of Trunk cross sectional area (TCSA) was for cv. Fuji and the minimum for cv. Starking, and difference was significantly. In the fourth

and fifth years after planting, the average yield per hectare ranged from 7.71 ton for Golab kohanz cv. to 33.73 ton for cv. Fuji. Fruits from cv. Fuji were the largest and Golab kohanz were the smallest. A fruit soluble solid was highest for cv. Starking and lowest for cv. Primerose. In addition quantitative and qualitative traits of fruit showed significant difference.

### S11.228

#### Evaluation of Central Leader and Modified Leader Training Systems on Growth, Yield and Fruit Quality in Some Apple Cultivars

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This paper presents the results of trial carried out on a loam soil two years consecutively in apple orchards situated in Horticultural research station of Horticulture department of Tehran University, Iran. The experiment was carried out in 2008-2009 on Golab kohanz, Delbar stival, Starking, Gala and Fuji trees/MM106 planted in a randomized complete block design (RCBD) with five treatments and four replications. Trees planted in spring 2006 and were drip irrigated. Trees were spaced in row at 2.5 m whereas the distance between rows equaled 4m. Trees were trained as typical Central leader and Modified leader forms. The Results showed that various cultivars were significantly different regarding to Trunk cross sectional area (TSCA) growth, yield and fruit quality. The maximum of TSCA was for cv. Fuji in Modified leader and the minimum for cv. Starking in Modified leader. The cv. Fuji in Central leader and cv. Golab kohanz in Modified leader had the highest and lowest yield in hectare, respectively. A fruit soluble solid was the highest for cv. Starking in Central leader and the lowest for cv. Golab kohanz in Modified leader and difference was significantly. In addition quantitative and qualitative fruit traits showed significant difference.

### S11.229

#### Minimizing Environmental Impact of Pesticide Applications in Orchards and Residues on Fruits

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In the EU-FP6 ISAFRUIT project a Crop Adapted Spray Application (CASA) system for precision orchard protection was developed. The system consists of three components: Crop Identification System – CIS, Environmentally Dependent Application System – EDAS, and a Crop Health Sensor – CHS. The CIS and EDAS components were assembled onto an orchard sprayer that minimizes spray drift by nozzle size (droplet size) selection and air support settings, and by the use of ultrasonic sensors that recognize the shape of the trees, thereby adapting spray volume to tree canopy volume. The CHS is the ultimate sensor that can recognize a disease. Altogether, the sprayer should minimize chemical residue in fruits and the environmental impact of agrochemical applications in orchard sprayings. To develop the CHS spectral analysis has been used based on the developments in crop sensing techniques for grassland and arable crop production. Crop health status, with as an example the infection of apple scab (*Venturia inaequalis*) on apple leaves, has been evaluated. The early detection of apple scab using spectral reflectance on the leaf opens new ways to develop a Crop Health Sensor (CHS) to be used for apple scab detection in the orchard and adapt the crop protection strategy as well. Application technique (i.e. sprayer type, sprayer settings and nozzle type), crop architecture and growth stage have all been shown to affect variability in deposit and residues on fruits. Different components of the CASA-system have been evaluated for deposition and residues on fruits; e.g. the effect of droplet size (nozzle type) on pesticides residues on apples and was evaluated in a commercial orchard. In general, the mean residue levels for the coarse and fine droplet applications did not differ significantly. However, large variations in residue levels were observed between the individual apples, either sprayed with coarse or fine droplets.

### S11.230

#### Quality Changes in Peach Fruit during Storage After Classification Using Non-Destructive (Acoustic, VIS/NIR) Techniques

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As in many fruits, variability is a big problem in peach production and marketing. Segregation of fruit into different classes at harvest can manage this variability by enabling different commercialisation practices. Our objective was to see if this segregation is maintained during storage and reflected in other quality characteristics. Peach fruit was harvested in 2008 at 4 different dates and followed during storage at 10 °C. The standard methodology to measure firmness, soluble solids content (SSC) and titratable acidity (TA) were combined with several non-destructive techniques, specifically acoustic (AFS) and spectrophotometric (VIS/NIR) techniques. Several optical chlorophyll related indexes (Ind1, Ind2, Ind3, Iad) were calculated from the spectra obtained using a spectrophotometer, using 2-3 wavelengths including the chlorophyll range and combining them in different ways. These optical indexes have been presented before as having great potential to characterize the maturity stage of peaches at harvest. These optical indexes were used to theoretically segregate fruit at harvest into 3 classes. The behaviour of these three classes was then followed in time. All the indexes did segregate the fruit well at harvest but this segregation was not always maintained during subsequent storage life. Segregation with Ind2 did present a strong possibility to segregate fruit that afterwards behave differently during storage at 10 °C.

### S11.231

#### Non-Destructive Fruit Quality Assessment in Apple by IAD-Index: Practical Perspectives

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Decisions on the optimal harvest time of apples are based on colour and destructive quality parameters like fruit firmness, total soluble solids and starch. However, variability in fruit ripening between individual fruits is often considerable, resulting in non-uniform lots. The index of Absorbance Difference (IAD) has perspectives for quick and reliable determination of fruit ripeness and optimal harvest time. The IAD is the difference in absorbance between two wavelengths near the chl-a peak. The IAD-index can be easily and non-destructively measured with a portable meter, which allows quick measurements in the orchard and in the packing house. In several apple cultivars the IAD-index, as well as the classical destructive quality parameters were followed in the weeks around harvest and during subsequent storage. This was done in different years and in different countries over Europe. The IAD-index was used to group the fruits into homogenous classes of ripening. Storage life of individual classes was followed. The results showed that the IAD-index decreased when harvest was delayed and further declined during storage. Moreover, it was demonstrated that apples can be graded at harvest into more homogenous lots, representing different IAD-classes. Although some correlations between IAD and classical quality parameters were found, further research is required to assess the robustness of the method in relation to cultivar, year and location. So far, it can be concluded that the IAD has perspectives to increase uniformity of apple lots and adjust post-harvest strategy (duration of storage, market) of these individual lots. As a result losses of fruits during storage decrease and consumers obtain a better fruit quality.

### S11.232

#### Innovation Strategies: An Integrated Theoretical Framework for Consumer Driven and Innovative Fruit Supply Chains

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This paper addresses the issue of which innovation implementation strategies should be adopted by consumer driven and responsive supply chains in order to increase their sales of fruits and fruit products. Consequently, the paper suggests transition strategies for increasing fruit consumption in Europe. Given that fruit consumption is associated with better health, but EU consumers eat less fruits compared to people from other regions, achieving this objective becomes critical. The basic assumption of this research is that fruit-related innovations (e.g., product, process, organizational, and marketing innovations) play a critical role in boosting fruit consumption. The article starts by reviewing the vast literature on innovation adoption. We propose a new theoretical framework that links transition, innovation and innovation implementation strategies at the supply chain level to successful innovation adoption by consumers. The framework is informed by empirically tested propositions of major innovation theories. The following are key elements of our theoretical framework: Innovation strategies of fruit supply chains fall into one or more of six types; offensive, defensive, imitative, dependent, traditional, and opportunist strategies. Innovation implementation strategies are grouped into 1) investing in continuous learning and knowledge acquisition, 2) market orientation, and 3) network participation. The realization of these strategies influences determinants of innovation success such as consumer technological awareness and commitment to brand name, the speed to market, technological competence, various cultural idiosyncrasies, etc. Successful innovations, in turn, boost product adoption by consumers and thus fruit consumption. The proposed framework is useful to fruit researchers, policy makers, and fruit industry executives interested in increasing fruit consumption.

### S11.233

#### Image Analysis and Classification Applied to Red Soft-Flesh Peach ('Richlady') Ripeness Assessment

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The present research is focused on the application of artificial vision to peach ripening assessment. Pigment changes during maturation and ripening can be detected through vision and reflectance techniques. Vision allows a spatially detailed determination of ripening stage as compared to spectrometry that gives an average determination of an area of the fruit. The considered optical indexes (Ind1, Ind2, Ind3 and IAD) are based on the combination of wavelengths close to the chlorophyll absorption peak. An artificial image of each index was obtained computing the corresponding reflectance images. Two analyses were applied for comparing the effectiveness and robustness of the indexes: a) Ripening sensing. The objective of this analysis was to determine which indexes better discriminate the ripening process. b) Robustness of the indexes in relation to convexity of the fruit. The objective of this comparison was to analyze which indexes are affected by the convexity. Large differences on the ability for discriminating ripening stages were found between the indexes through Wilks'  $\Lambda$  (ratio between inter-group variance and the residual variance).  $\Lambda$  were computed between index values of each fruit before and after ripening. Ind2 showed the highest  $\Lambda$  for all the fruits. Ind2 is a normalized index that is focused on the shape of spectra at chlorophyll absorption peak. All indexes showed to be able to correct convexity (correlation coefficient R, between the index values for all pixels and their radial position was 0.01 to 0.24), except for the just-harvested peaches and for Ind1 (R=-0.66). As a conclusion Ind2 is the



preferred index: it shows parallel evolution of average and range values of the fruits, lower variability within fruits, better discrimination between ripening stages and no influence of convexity. In addition, Ind2 allows the differentiation of ripening regions within the fruits and shows the evolution of those regions during ripening.

### S11.234

## A Virtual Fruit Model to Analyse the Impact of a Mutation on Peach Fruit Quality

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The purpose of this paper is to show that an ecophysiological model can be used to compare and contrast the state of a virtual wild-type system and a virtual mutant, and analyse the impact of a single mutation on different processes. In this case, a model for fruit development build in the framework of the UE project, ISAFRUIT, has been used to describe the relationships between fruit growth, sugar, citric acid and water accumulation, transpiration, respiration and ethylene emission. The virtual mutation tested is a single mutation which decreases the fruit's requirement for carbon. The mutation triggered large effects in several variables of the fruit development model (growth, respiration and metabolism) and delayed the fruit developmental rate. Such a virtual approach could lead to new ways of exploring the impact of mutations, or naturally occurring genetic variations, in silico under differing environmental conditions.

### S11.235

## Transitioning to Organic Fruit Growing: Relevance of a Decision Tool

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The decision to switch from integrated or conventional to organic production should be prepared carefully. Farmers are often willing to switch to organic because of a better valorization. However the transition should not be an absolute economy-based decision. Orchard management in organic farming requires an overall knowledge of the production related (crop, the pest and diseases, the available products, cultivars) and economic (prices, quality-standards, markets...The complexity in organic apple production leads to high technical challenge for apple grower, and unfortunately sometimes to failures. Facing a lack of advisory availability, we considered, in the frame of Isafruit, the possibility to propose a user-friendly decision tool, based on qualitative modeling and attributes aggregating, to help the fruit grower taking the right decision. We used DEXi, a freeware which has been developed in different fields, including agricultural ones. DEXi organizes a complex 'life' problem into smaller sub-problems that will all be discussed one after the other by experts (agronomists, economists, advisors), and hierarchized with decision rules. Discussion with experts has to be done through physical meetings, and is time consuming. This led to the difficulty to work with European colleagues, and to the need to reorganize the group at the national/regional scale. So far, the model structure is achieved. Attributes shall now be weighed and organized under decision rules. Afterwhile, ex-ante validation of the model will be done in organic farms, to compare on-farm reality with the model conclusions. The finalized tool will be brought to web-users through a simple interface. It should tell the fruit grower if his orchard is adapted to organic, or if some specific patterns should be improved before considering the transition, thus avoiding failures in the long term strategy of the farm with strong losses.

### S11.236

## The Key Functionalities of the "People" Decision Support System Interface

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The aim of creating People software, a Decision Support System, was to deliver a functional and easy-to-use tool for simulating quality decay of apples and peaches

along user-designed supply chain scenarios. The foundation of the software is mathematical models (formulas) for changes in fruit quality parameters (e.g. firmness, acidity) through time, given exterior conditions like: time, temperature, storage atmosphere and initial fruit status. People eases use of these models by letting users to design custom supply chain scenarios, setting environmental parameters for individual supply chain steps, fruit information (cultivar, growth location) and initial fruit quality parameters. Given this input People software uses built-in models to simulate fruit quality along the time axis and present it as a report or graph. Users can create more than one supply chain scenario in one project and apply models simultaneously to compare effects of different environmental factors on fruit quality decay. The key People functionalities are: • Built-in wizards for easy creating new project and simulation setup; • Built-in various mechanisms for validating correctness of user input data; • Dynamic model availability for user defined fruit (models depend on fruit species, cultivar, growth location) • Easy design of supply chain scenarios (predefined chain steps, chain step shuffling, most design actions require only a few mouse clicks); • Creating reports and graphs of simulated quality changes along the designed supply chains; • Simulating several supply chains in one step for scenarios comparison; • Customizable graphs (line colors, markers); • Multilanguage interface; • Built-in math models may be tuned or changed by user by editing xml file.

### S11.237

## Strawberry Production Chain: Application of a LCA Model

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Cultivation of the strawberry is of individual and collective imagination the idea of a product "healthy", "clean" and "natural." This motif leads producers and distributors wanting to improve the environmental sustainability through eco-friendly means of production without reducing the quality and profitability. To exploit this crop and improving its quality is important to take an overall view of the entire production process in order to understand the criticality of the system is at the stage of field work and / or distribution to be able to improve and take action various steps of the production process. The preparation of a budget, which is able to analyze the effects of primary and secondary production, consumption and disposal of property, is becoming increasingly important in assessing the sustainability of a production process whatever it is. Marketing channels for vegetables and strawberries in particular have evolved over time from marketing arrangements at local fundamentally linked to the traditional market and the retail sales to large circuits of distribution. In parallel there have been changes also the inputs and outputs related to this crop at each step of the supply chain and increasingly went outside elements to influence the choice of the agent. Objective of this work is the application of a model of LCA study to the production chain of fresh strawberries for a productive distribution area of most interest in Piedmont. In particular, we will seek to differentiate the study during post-harvest packaging of fruits. Will face a packaging system that uses a traditional (perforated film) film with biodegradable material (corn starch).

### S11.238

## Probabilistic Intake Calculation from Pesticide Residues in Apples Sprayed by Two Different Application Techniques

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An investigation within the ISAFRUIT project was performed to find a way to decrease the pesticide used for apple production and the pesticide residues in the fruits. Within this investigation, the residue variability, associated with individual apples samples, was studied for two application technique; i.e. fine and coarse drop-

let spray application. Field trials were performed in a commercial orchard with pesticides routinely used for pest management in apple production. The apple variety was Jonagold. A standard commercial spraying scheme was used, involving the insecticide and fungicides. Apple trees were sprayed with either Standard or Venturi nozzles, throughout the whole spraying season. Four apples were collected from each of four positions within the tree. Results of the pesticide residues have shown that no differences were seen in the mean residue concentration. However, very large variations were seen between the positions and within the positions (9-27 times). For the acute human toxic effects the variation in residues is of great significance. Therefore, the residue data will be used for probabilistic modeling for the short-term dietary. The modeling will be performed separately for residues data from the two different application modes. Differences in exposure according to gender and age will also be taken into consideration. The consumption data used in the calculations will be from the Danish dietary survey for year 2000-2002. In the probabilistic modeling single data for residues and single data for consumption is combined and therefore the output is a distribution instead of a single point in the deterministic approach.

### S11.239

#### New Sustainable Methods to Produce and Store Fruits

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Fruit quality is badly defined since the parameters mainly considered are fruit size and skin color. Other attributes such as flesh firmness, sugar content, acidity and aroma are seldom considered. Up to now, several studies have been carried out on fruit quality assessment by using traditional methods, which do not consider other quality traits, as antioxidant power, aroma, soluble sugars and organic acids content. The assessment of these parameters is time consuming and requires sophisticated equipments. In recent years, extensive research has been focused on the development of non-destructive techniques for assessing internal fruit quality attributes allowing to extend the assessment to a high number of fruit, to repeat the analysis on the same samples and to achieve information on several fruit quality parameters. Among the non-destructive techniques, visible/Near Infra Red spectroscopy (vis/NIR) can be efficiently used for determining traditional fruit quality traits and concentration of the main organic acids and simple sugars. In addition, this technique allows to define a new maturity index strictly related to fruit ethylene emission and ripening stage. This index, called "Absorbance Difference" (IAD), can be used for precisely determining harvest date, and for grouping harvested fruit in homogeneous classes.

### S11.240

#### Reducing Foodborne Pathogens on Fresh-Cut Fruit by Biopreservation

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Minimally-processed produce does not suffer any treatment that guarantees the total elimination of foodborne pathogens. Currently, sodium hypochlorite is used to reduce microbial contamination. However, there is a growing concern about its use and new alternatives should be investigated. Biological control or biopreservation is a promising alternative consisting in extending the storage life and safety of foods through the use of natural microflora or their metabolites. Biopreservation is being successfully used in other foods. In ISAFRUIT project, our objective was to study the feasibility of using biopreservation as an alternative to sodium hypochlorite to reduce foodborne pathogens on fresh-cut fruit. About 100 microorganisms isolated from fresh and fresh-cut fruit and 29 lactic acid bacteria from dairy products were tested against main foodborne pathogens at *in vivo* conditions on fresh-cut apples and peaches at different temperatures. Two of them showed great efficacy in reducing Salmonella, E. coli O157:H7 and *Listeria* spp., with reductions >2-log units. Identification, phytopathogenicity on tobacco plants, production of secondary metabolites, optimum dose of application and their effect on fruit qual-

ity has been investigated. Moreover, the effect of several bacteriocins was also tested against *L. monocytogenes* on fresh-cut apple and melon. Nisin showed promising results, with greater reductions than sodium hypochlorite. Biopreservation could be an alternative to chemical preservatives to control growth of FBP on fresh-cut apples, and thus improving their safety. Further research is necessary to find effective treatment combinations and to develop these treatments and bio control agents for commercial application.

### S11.241

#### Plant Volatile Compounds to Control Brown Rot in Stone Fruits

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Several volatile compounds, naturally occurring in plant products commonly used in human diet, were tested for their activity against *Monilinia laxa*. In *in vitro* assays, the conidial germination and mycelial growth were consistently inhibited by the vapour of some isothiocyanates (allyl-isothiocyanate, 4-methylthiobutyl-isothiocyanate and butenyl-isothiocyanate), trans-2-hexenal, carvacrol, citral and trans-cinnamaldehyde. Other compounds such as hexanal, (-)-carvone, eugenol, 2-nonanone and p-anisaldehyde exhibited progressively lower inhibition. The most active compounds in *in vitro* studies were successively tested as postharvest vapour treatments to control brown rot on stone fruits. Allyl-isothiocyanate provided the best control of brown rot in peaches and nectarines (80-100% efficacy, with 0.04 mg·L<sup>-1</sup>) without causing negative effects on fruits. Trans-2-hexenal (10-20 µL·L<sup>-1</sup>) significantly reduced *M. laxa* infections in apricots, peaches, nectarines and plums (efficacy ranging from 46.2% to 80.3%, depending on cv.), while citral and carvacrol (50 µL·L<sup>-1</sup>) showed a low degree of efficacy. Concentrations of trans-2-hexenal effective in decay control (10 µL·L<sup>-1</sup> in apricots, 20 µL·L<sup>-1</sup> in peaches, nectarines and plums) were phytotoxic to apricots, nectarines and peaches, while they did not cause any visible disorder to plums. Off odours or off-flavours (green-bitter, grapefruit like) were perceived in fruits after exposure to trans-2-hexenal vapour. Among the natural compounds tested, allyl-isothiocyanate proved to be very effective in *Monilinia* control without affecting fruit quality and taste.

### S11.242

#### Trans Europe Demo Tour of the Crop Adapted Spray Application Prototype Developed in the Ambit of ISAFRUIT

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A prototype of orchard sprayer provided with a Crop Adapted Spray Application system was realised in the ambit of the European Project ISAFRUIT. The sprayer is equipped with a Crop Identification System (CIS), based on ultrasonic sensors, that enables to automatically adapt the application according to the canopy target (size and density), and with an Environmentally Dependent Application System (EDAS) that allows to automatically switch from conventional to air induction nozzles and to share the air flow between the left and the right side of the machine according to the sprayer position in the field and according to wind conditions. Moreover, the prototype is designed to host also a Crop Health Sensor system (CHS), that is still under development and that will enable to detect the health status of plants in the orchard and therefore to adjust the parameters of the spray application accordingly. Between June and October 2009, the CASA sprayer was presented in 8 outdoor demonstrations which took place in seven different European countries (Denmark, Italy, the Netherlands, Germany, France, Poland and Spain). The demonstrations consisted in a presentation of the characteristics of the CASA sprayer prototype by means of slides and in a field demonstration of the machine functioning. In each demonstration place artificial targets were employed to demonstrate CIS functions

while a path equipped with signs to simulate the orchard rows and the sensitive areas was used to enhance the functioning of EDAS. Leaflets and brochures were prepared and translated in the different European languages. The Trans Europe Demo Tour raised a lot of interest as more than 1700 people attended the 8 demonstrations, including researchers, sprayer manufacturers, plant protection industry representatives, advisers and farmers. The events were reported and spread out by local and national magazines, and more than 30 between articles and newsletters were published.

### S11.243

#### Firmness Loss and Cell Wall Degradation After Air- or CA-Storage of 'Rich Lady' Peaches

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Refrigeration is one of the main tools used to prevent rapid softening of peaches (*Prunus persica* L. Batsch), which severely limits commercialisation of produce. However, cold storage of peaches under inappropriate conditions leads to a range of chilling-induced disorders, which also compromise quality and storage potential, but can be alleviated through storage under controlled atmosphere (CA). It is generally assumed that firmness loss of fruits is the result of ripening-related modifications in the cell wall, although current information in this regard is inconclusive. In this work, 'Rich Lady' peaches were picked at commercial maturity, stored at 2 °C and 92% RH under air or CA (3 kPa O<sub>2</sub> : 10 kPa CO<sub>2</sub>) for 3 or 15 days, and subsequently kept in air 1 day at 7 °C to simulate refrigerated transport (henceforth, 3+1 and 15+1 fruit, respectively). After cold storage, samples were placed at 20 °C, and fruit firmness, cell wall composition and some cell wall-degrading enzyme activities were analysed 0 and 3 days thereafter. Although CA conditions clearly inhibited pectin methylesterase activity, which is necessary for further pectin depolymerisation by polygalacturonase (PG) and pectate lyase (PL), little differences in fruit firmness were found between air- and CA-stored peaches upon removal from cold storage. However, CA storage of peaches resulted in higher content of cell wall material regardless of storage period. Multivariate analysis of data indicated that firmness was closely related to pectin content rather than to total cell wall material content or to the content of other cell wall polymers such as hemicelluloses. Therefore, other pectin backbone-loosening mechanisms in addition to depolymerisation by PG and PL might be involved in softening of 'Rich Lady' peaches after cold storage.

### S11.244

#### Effect of Application Date of Three Rest Breaking Agents on Growth and Production of "Royal Gala" and "Granny Smith" Apple

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The efficacy of chemical Rest Breaking Agents (RBA), used to reduce the negative effects of insufficient winter chilling, depend on application date, concentration, product and cultivar. As environmental concerns increasingly limit the use of agricultural chemicals, safer and existing products must be applied judiciously. One-year-old shoots were excised from mature Royal Gala (RG) and Granny Smith (GS) apple trees six times during August and September 2008 and forced at 25 °C to determine depth of dormancy. These trees were treated with either DormexR/oil (0.5%/3% v/v), LiftR (3% v/v) or SymphonyR (16%N, ½ & ¼ volume) on the same six occasions and bud break (BB) and yield recorded. Rate of emergence from dormancy of forced shoots significantly increased after mid September and mid August for RG and GS respectively. In both cultivars, the effect of the RBA on BB of the tree corresponded to the rate of emergence from dormancy. DormexR/oil and LiftR increased (>35%) the normal bud break (<40%) of RG but application date had no effect. RBAs did not affect RG total yield but early applications increased production of early, larger fruit with improved colour but reduced total production. Untreated GS bud break was low (<20%), and was significantly increased (>40%) by applications from early September of DormexR/oil and LiftR. Neither RBA nor application date influenced GS yield.

### S11.245

#### Effect of Rootstock, Harvest Date and Storage Time on 'Forelle' Pear Fruit Maturity After Storage

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The export pear cultivar 'Forelle' may sporadically develop Mealiness, a dry texture disorder, after cold storage. The cause has been associated with maturity at harvest, high temperatures prior to harvest or insufficient cold storage. Fruit from 'Forelle' on six rootstocks in one orchard were harvested before and after commercial maturity during two seasons. Fruit were then cold stored for 10, 12 and 14 weeks at -0.5 °C and regular atmosphere, and then for one week at 15 °C. Fruit maturity parameters (firmness, TSS, colour, blush and mealiness) from each rootstock were recorded at harvest and after each storage period. Harvest date influenced all parameters and the changes that occurred during storage in both seasons. Rootstock vigour influenced harvest maturity in both seasons. Fruit from the more vigorous rootstocks BP1 and BP3 were greener with lower TSS and less blush, but with similar firmness and with higher N and Ca than fruit from the more dwarfing rootstocks OHF97, QA, QC51 and BA29, and they also did not ripen normally. During the first season fruit firmness increased during the first 10 weeks storage, but during the second season fruit firmness decreased during storage. Fruit firmness at harvest influenced changes during storage. Fruit TSS and colour increased mostly during the initial 10 weeks storage in both seasons. There was little change in blush in both seasons. There was no storage breakdown after any cold storage period but all fruit became mealy during one week at 15 °C. Mealiness developed faster in fruit harvested more mature. These results provided no definitive answer as to the relationship between fruit maturity at harvest and development of mealiness after storage.

### S11.246

#### A Large Scale View of Thinning in Apple Orchards: A Spatial Analysis of the Orchard Thinning Effect

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Precision horticulture is a new technological area aimed at reducing production costs while improving crop performance and environmental quality. This concept is still poorly integrated worldwide in fruit growing operations and techniques. At present, information on crop performance along the season is seldom available, and this can cause considerable loss of fruit quality and quantity at harvest time. Crop load data taken prior to hand thinning and before harvest time were collected in three blocks of a commercial apple (*Malus domestica* Borkh.) orchard in the province of Ferrara, Italy. The aim of the survey was to characterize the within-field variability of crop load, using spatial statistics, and to improve the effectiveness of the post-chemical, hand-thinning treatment. Crop load was measured in 156 sites prior and after hand-thinning over a defined distance (0.8 m) and the data were used to model a variogram and associated spatial variation. Variability in the spatial distribution of fruit load per tree was observed before hand-thinning, indicating the possibility to differentially manage the orchard, according to location. Spatial variation in fruit number was absent post thinning, indicating that thinning had removed the previously observed spatial pattern. Under the current uniform management approach this indicates that thinning has been effectively implemented. However, the spatial variation observed prior to thinning may indicate a variable crop load management strategy for maximizing quality in the orchard.

### S11.247

#### Ripening Monitoring of Apples: Comparison of Different Types of NIR Devices

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In this study 3 different NIR devices were evaluated as non destructive instruments to monitor apple ripening. Three weeks before to one week after optimal harvest date, 25 fruits of two apple cultivars (Diwa® and Modi®) were weekly measured. The DA-Meter (Sintéleia, IT) as well as the Phazir device (AnalytiCON instruments, D) are portable and handheld instruments and were tested for the measurements of the fruits directly on the trees. At each time of measurement the apples were picked and measured in the lab with NIR Case (SACMI, IT), another portable NIR device but not handheld. The same fruits were measured with classical destructive methods in order to determine flesh firmness, total soluble solids, acidity and starch content. The performance of each NIR instrument was then evaluated on the basis of multivariate statistic analysis.

### S11.248

#### Temperature Dependent Ethylene Metabolism during Storage in Peach and Nectarine

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The objective of our research was to quantitatively follow the ethylene metabolism intermediates and enzymes of peach and nectarine during storage at different temperatures. The peach and nectarine were harvested in 2008 and 2009 respectively at the commercial harvest date and stored at 3 different temperatures (10 °C, 4 °C and -1 °C). The measurement interval depended on the temperature and the changes were recorded until no further firmness changes were noted. The content of 1-aminocyclopropane-1-carboxylic acid (ACC) and its conjugated form 1-(malonyl) aminocyclopropane-1-carboxylic acid (MACC) were measured as well as ACC synthase (ACS) and ACC oxydase (ACO). In peach, temperature affected ACC production especially at -1 °C for which a complete inhibition was observed. At higher temperatures, the production of both ACC and MACC was higher. A sharp increase in ACS and ACO activities were found when the fruit were stored at 10 °C. At 4 °C the increase in ACS activity was significantly delayed and no changes in activity were found when the fruit were stored at -1 °C. In contrast to ACS, storage at 4 °C did not induce an increase in ACO activity. Changes in ACC metabolism were linked with the firmness changes followed over the same period. A similar trend was observed in nectarine fruit. These results show that ACS and ACO are differentially regulated by temperature. This difference may explain the specific ripening behaviour of stone fruit during cold storage and related to the occurrence of chilling injury in this kind of fruit.

### S11.249

#### Reflective Mulches Affect the Daily Patterns of Vascular and Transpiration Flows to/from Peach Fruit

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The application of reflective mulches in peach orchards often results in higher fruit quality at harvest. This might be due either to an increased carbon assimilation at whole canopy level and/or to modified environmental conditions in the orchard which enhance fruit strength as sinks. In this study, the effect of Extenday® reflective mulches on the daily variations of peach fruit growth was tested on two nectarine varieties: the mid-season cv. Red Gold and the early season cv. Alice-col. In both cultivars, growth rate, vascular and transpiration flows were measured during the

cell expansion stage on four-five fruit on Extenday® reflective mulches, using the method developed by A. Lang. The daily patterns of phloem, xylem and transpiration flows to/from the fruit were determined by continuous monitoring of fruit diameter by custom-built, automatic fruit gauges. Canopy micro-environmental conditions and midday leaf, stem and fruit water potentials were also determined in both Extenday® and control. At harvest, fruit size, soluble solids content and dry matter percentage were measured on Alice-col fruit. Extenday® mulches increased canopy VPD, and caused higher fruit transpiration during midday hours. This decreased midday fruit water potential and enhanced the gradient needed for xylem and phloem transport to the fruit. As a consequence xylem and phloem inflows to Extenday® fruit were higher during the afternoon and the night and increased fruit RGR at this time of day. Also, higher soluble solids and dry matter contents were found on Extenday® fruit at harvest. These results suggest that reflective mulches may increase peach fruit strength as a sink by promoting fruit transpiration through modified environmental conditions in the orchard.

### S11.250

#### Effect of Crop Load in First Leaf on Apple Tree Growth and Productivity

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Quality one-year-old nursery trees of apple cultivars: 'Golden Reinders', 'Granny Smith' and 'Red Chief', with more than seven lateral shoots, were planted in 2008 and loaded with fruits the same year. In cultivars 'Red Chief' and 'Granny Smith' two levels of crop loading were applied (3 and 6 fruits per tree), but cultivar 'Golden Reinders' had six levels of crop load (3, 6, 9, 12 and 15 fruits per tree). Control treatment was without the fruits. Standard planting density was 3.2m x 0.8m and trees were formed like slender spindle. Crop load in 'Red Chief' did not influence increasing of the trunk cross section area (TCSA), while in cultivar 'Golden Reinders' reduction of TCSA was determined in treatments with 9 or more fruits per tree. In cultivar 'Granny Smith' crop load effectively increased the growth as well. In cultivar 'Red Chief' number of shoots and its total length were lower on more fruitful trees than in control treatment. 'Golden Reinders' had lower number of shoots and its total length in treatments with 9 or more fruits per tree, while in 'Granny Smith' appeared same in treatment with 6 fruits per tree. Crop load influenced the yield, so treatments with 6 fruits per tree in cultivar 'Red Chief' gave 4.6 t/ha, in cultivar 'Golden Reinders' 4.03 t/ha, and in cultivar 'Granny Smith' 4.7 t/ha. Treatments with higher crop load had lower fruit weight in cultivars 'Red Chief' and 'Granny Smith', while in cultivar 'Golden Reinders' only treatment with 15 fruit per trees gave smaller fruits. Crop load influenced the lower formation of flower-buds and cultivar 'Red Chief' had its insufficient number. However, cultivars 'Granny Smith' and 'Golden Reinders' in treatments with 3 and 6 fruits per tree formed enough number of flower-buds for optimal yield in the second leaf.

### S11.251

#### Changes in Cell Wall Structural Components and Degrading Enzyme Activities during Shelf-Life of 'Elstar' and 'Pinova' Apples

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Within the ISAFRUIT project framework, (work package 4.2 Optimal Quality) a decision support system (DSS) for fruit quality chain management is currently under development. The DSS model simulates the quality changes that occur during fruit ripening in storage and shelf-life and it requires numerous parameter estimates for its development and validation. Fruit softening is an important component of the DSS. Many different factors such as: cultivar, temperature, ripening stage, site and storage conditions and treatments influence postharvest softening processes in apple. Softening is strongly related to cell wall degrading enzymes that hydrolyse cell wall structural components. This work monitors changes in cell wall structure

and the activity of cell wall degrading enzymes during shelf-life of apples. The influence of the ripening inhibitor 1-MCP on softening processes was also investigated. 'Elstar' (a rapid softening apple) and 'Pinova' (slower softening) were harvested 1 wk after commercial harvest (optimal time for 1-MCP treatment) and treated with 1-MCP and then held at 10 °C in normal air for 10 wks. Samples were taken at harvest and at weekly intervals to determine fruit firmness, enzyme activity ( $\beta$ -galactosidase; endoglucanase; polygalacturonase; pectatelyase; pectinmethylesterase) and to quantify cell wall pectin fractions. 1-MCP treatments maintained fruit firmness in both cultivars, although the effect was more evident for 'Elstar' than for 'Pinova'. The total amount of pectin clearly decreased for both cultivars, although there was no difference between the 1-MCP treatment and untreated control. Solubilised pectins (not cross linked in cell wall) were reduced in the 1-MCP treatment when compared to the untreated control to indicate more softening in untreated fruit. Cell wall enzyme analyses are still in progress, but results will be available at the congress.

### S11.252

#### Differences in Leaf Pigment Composition, Photosynthetic Rates and Chlorophyll a Fluorescence of Two Pear Cultivars After Sudden Drop in Temperature

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The purposes of this study were to identify different ecophysiological responses of two pear cultivars ('Ninglv' and 'Huanghua') to sudden chilling, reveal the underlying mechanisms and provide some theoretical bases to select high tolerant varieties. In this study, the leaf pigment composition, chlorophyll fluorescence parameters and photosynthetic rates of two pear cultivars were measured under field conditions after sudden drop in temperature. The results showed that 'Ninglv' pear had higher chlorophyll content, the maximum photochemical efficiency of PSII (Fv/Fm), photochemical quenching of PS II (qp), maximum activity of PS II (Fv/Fo) as well as electron transport rate (ETR), actual quantum yield of PSII photochemistry ( $\Phi$ PSII), net photosynthetic rate (Pn) and Pn/ $\Phi$ PSII ratio. It indicated that the 'Ninglv' cultivar had higher photosynthetic capacity, PSII photochemical efficiency and stronger low-temperature tolerance than 'Huanghua' cultivar.

### S11.253

#### Effect of 1-MCP on Gala Apple Cultivar: Comparison Between Two Different Cold Storage Temperatures

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Nowadays, saving energy in productive systems such as fruit production and fruit storage has become an issue of big concern. On one hand, the price of energy is high and therefore there is the need to reduce energy costs in order to enlarge the benefit that producers can get from their fruit. On the other hand, fruit producers are required to produce in a more environmentally-friendly manner, and reducing energy inputs is a way to achieve this objective. 1-MCP seems to be capable of maintaining a high fruit quality without the need to store the fruit under a very low temperature. Therefore, the use of 1-MCP as a postharvest treatment can reduce the energy cost of the fruit cold storage. In order to test it, a comparison between two cold storage rooms with the same characteristics but with different storage temperature was carried out. The study was conducted in the northeast of Spain, in the Girona area, with Gala apple variety. One storage was set at 1.5 °C with Gala treated with 1-MCP and the other storage was set at 0.5 °C with Gala without 1-MCP treatment. The two rooms were filled simultaneously with fruit with the same characteristics and origin. Three different orchards were selected to carry out the evaluations and one palox with fruit of each orchard was put into each room. At the end of the cold storage, fruit quality and energy consumption will be evaluated and compared.

### S11.254

#### Influence of Maturity Stage on Apple Storability and Postharvest Fruit Quality

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Investigations were carried out at the Lithuanian Institute of Horticulture in 1996-2006 with apple cultivars 'Shampion', 'Lobo', 'Ligol', 'Lodel', 'Alva', 'Auksis' and 'Noris'. Fruits for storage were harvested 5 times at weekly intervals before, during and after predictable optimum harvest date. Quality changes, presence of storage disorders, mass losses were measured during harvest period and at the end of storage. Maturity indexes were calculated at each picking date. During investigation period fruit quality parameters changed according to harvest date and were specific for each cultivar. Later harvested fruits were softer and had higher content of soluble solids, though post-storage SSC was not significantly affected by harvest time. The softening rate of apple fruit varied from cultivar to cultivar: fruits of cv. 'Shampion' tended to lose their firmness slower than 'Auksis', 'Lobo' and 'Lodel', however more faster than fruits of cv. 'Ligol' and 'Alva'. Fruit storage ability was closely connected to fruit maturity. Fruits picked at the optimal harvest time lost less mass during storage than fruits picked too early or too late. According to the test panel evaluation fruits picked later had the best external appearance though their taste properties were lower. Optimal harvest time was estimated for every cultivar according to fruit quality parameters and storage ability.

### S11.255

#### Apple Fruit Quality Changes during the Ripening

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Investigations of fruit quality changes during the ripening period were carried out at the Lithuanian Institute of Horticulture in 1996-2006 with seven commercially important apple cultivars 'Shampion', 'Lobo', 'Ligol', 'Lodel', 'Alva', 'Auksis' and 'Noris'. Fruit quality measurements were started 2-3 weeks before estimated optimum harvest date. Apples were harvested 5 times at weekly intervals. Changes of fruit physiological and biochemical parameters depended on harvest date and were specific for each tested cultivars. Later harvested fruits were softer, had higher starch index, SSC and were less acid. Strong negative correlation between firmness and harvest date was observed for all investigated cultivars. During 5 week period fruit mass increased by 16-37%, fruit colour by 27-42%, while fruit firmness decreased by 14-28%. Titratable acidity was not stable character during the years of investigation though the pattern of changes of TA during maturation period was the same for all cultivars. The similar tendencies of changes were observed in sugar content and sugar/acid ratio. The starch index was one of the most stable quality parameter for the most of tested cultivars, but for some of them it could serve as additional parameter only. Hot and rainy conditions at the end of fruit development period could influence significant reduce of SSC, sugar content sugar/acid ratio and increase of titratable acidity.

### S11.256

#### Influence of Rootstock M 26 on Four Apple Cultivar Growth and Yielding in Latvia

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The rootstock M 26 is one of the most popular rootstocks in the temperate climate zone. However, there is no clear information about this rootstock's interactions with commercially grown cultivars in Latvia. Four apple cultivars of different origin - 'Auksis' (originated in Lithuania), 'Zarya Alatau' (Kazakhstan), 'Lobo' (Canada), 'Sinap Orlovski' (Russia) were planted in spring of 1998 as one year old trees on rootstock M 26 in Dobeles, at distances 1.5 × 4 m, in three replications, without irrigation. The soil was sod calcareous loam with pH 7.1, 2.3% organic matter and plant available K<sub>2</sub>O and P<sub>2</sub>O<sub>5</sub>, respectively 149 mg·kg<sup>-1</sup> and 113 mg·kg<sup>-1</sup>. The first significant yield was obtained in the fourth year after planting. In the twelfth year of growth the largest trunk cross sectional area and widest canopy had cultivars

'Auksis' and 'Sinap Orlovski', which required larger planting distances in row. The difference between cultivars was significantly high. These two cultivars showed also the largest cumulative (total) yield of nine years. The yield efficiency (cumulative yield on trunk cross sectional area) was the highest for cultivar 'Sinap Orlovski', slightly less it was for 'Zarya Alatau' and 'Auksis', however, influence of cultivars was not proved statistically. The lowest yield on rootstock M 26 was obtained for cultivar 'Lobo'. Although all cultivars had more or less biennial yielding, the difference between cultivars was statistically provable. Smaller biennial yielding was shown by the lower yielding cultivar 'Lobo' and productive 'Sinap Orlovski'. The largest yield fluctuations year by year had cultivar 'Zarya Alatau'. The cultivars had significant influence on fruit weight - the largest fruits had cultivar 'Sinap Orlovski', the smallest 'Zarya Alatau'.

### S11.257

#### Determination of the Geographical Origin of Apples with Element Composition of Fruit

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Japanese 'Fuji' apple is exported almost exclusively to the Taiwanese market, where it competes mainly with apples from South-Korea and the USA. The objective of this study was to determine the geographical origin of 'Fuji' apples on the basis of their element composition. Concentrations of 10 elements (B, Mn, Fe, Cu, Zn, Sr, Ba, Ni, Ti, Al) were determined by ICP-AES from the peduncles and seeds of 63 samples originating from Japan and 40 samples from the USA, South-Korea and China. The element concentrations in the peduncles and seeds were higher than in the other parts of the apple. Thus peduncles and seeds are the suitable parts for measuring the element concentrations in order to distinguish the geographical origin. Using the analytical results of 7 elements (B, Mn, Fe, Cu, Zn, Sr, Ba) measured either in the peduncles and in the seeds for linear discriminant analysis, foreign or domestic origin of 96.1% of the 'Fuji' apple samples could be classified correctly. By a canonical discriminant analysis that used 10 elements of the peduncles and 8 elements of the seeds, 97.5% of 'Fuji' apple samples from China, South-Korea and the USA were classified correctly. By a canonical discriminant analysis that used 7 elements of both the peduncles and the seeds, 98.9% of 'Fuji' apple samples from Japan, South-Korea and the USA were classified correctly. Based on these results, we think that a reliable determination method of the Japanese geographical origin of 'Fuji' apples was attained.

### S11.258

#### Abscisic Acid, a New Use of a Known Plant Hormone. Evaluation of its Effect on Stone Fruits

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Abscisic Acid (ABA) plays several roles on plant growth and development as related to the environment interactions. ABA is strongly correlated with dormancy, fruit and leaf abscission and abiotic stress tolerance (stomata control). In addition, ABA affects source-sink relationship, fruit ripening, biotic stresses and root branching. Recently, a new formulation suitable to be used under field conditions has become available. This new formulation was tested, under our climatic conditions, as a thinning agent of stone fruits (plum and nectarine) since there are no efficient chemical thinners available for stonefruit and "hand thinning" is consequently the most adopted method. This formulation also confirmed its potential in affecting water use, an aspect that nowadays assumes an extremely important role considering that a rational use of the natural available resources (i.e. water) has a paramount importance.

### S11.259

#### Use of Natural Occurring Compounds to Affect Skin Colour and Nutraceutical Properties on Several Apple Cultivar

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The use of natural occurring chemical could represent a tool to solve agronomical problem (such as lack of skin colour and attractiveness of the fruits). Compounds such jasmonates or amino acids (L-proline) proved in pluriennial trials to positively affect skin colour in several apple cultivar. JAs in a PDJ formulation was sprayed 20 and 10 days before the expected harvest while L-proline was applied 3 times since June drop. Different concentrations were also tested. In addition JAs were also applied on detached fruits to verify the effect of the chemical as affected by different UV light exposure and temperature. Skin colour induced by the chemical application was assessed by DAMeter, Avamouse colorimeter and the pigments responsible for the red colour were assessed using HPLC analyses. Treatments enhanced the total phenolic content, in particular anthocyanin including idaein, the major anthocyanin in apple fruit. As far as the detached fruit experiment is concerned, the results pointed out synergistic response between PDJ, UV-light, temperature, fruit ripening stage for regulation of apple pigment pathways. Here are presented data related to the application of jasmonic acid and L-proline on fruit of Gala, Fuji and Pink Lady.

### S11.260

#### Reflecting Mulch to Affect Fruit Quality and Nutraceutical Properties in Nectarine

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This research work was conducted under the framework of Isafruit Project and aim to investigate the effect of different light microenvironment on final overall quality of nectarine fruit production. Experiments were conducted in a commercial orchard of nectarine 'Stark Red Gold' during years 2006 and 2007. Reflective mulches were laid down in the inter-row space in mid May. Environmental conditions as affected by mulching (such as temperature and reflected light) were monitored till fruit harvest. Production per tree was enhanced by treatment in both years, but differences were statistically significant in 2006 only, when average fruit weight was also enhanced. Nectarines were more ripe in 2006 season whereas no differences in the main fruit quality indices were detected in 2007. Phenolic compounds concentration in ripe nectarines was positively enhanced in both years. An increment in the overall phenolic compounds of a 100 g portion of fresh fruits was calculated in about 60% in 2006 and 2007, therefore determining a very interesting improvement in nectarines nutraceutical and antioxidant potential activity. Experiments were also conducted with UV+white light irradiation under controlled condition. Phenolic compounds accumulation and, specifically, anthocyanins concentration in nectarines previously screened with paper bags were determined at different times after irradiation. Results clearly indicate an inducing effect of UV+white light irradiation on the basic mechanism of synthesis and accumulation of anthocyanins in fruit skin. Consequences on nectarine color and healthy potential are discussed.

### S11.261

#### The Effect of GA3 and GA4+7 Spray Application on Russetting Control of Some Commercial Apple Cultivars in Climatic Conditions of Karaj, Iran

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Russetting usually damages apple skin, particularly when the humidity and rainfall are high. Russetting is characterized by the development of a cork layer along the epidermal cells that giving an appearance of rough to the fruit surface. The main cause of russetting is mostly genetical trait and it may accelerate with rainfall and high humidity. In order to control and examine the russetting in Iran (Karaj) climatic conditions, this experimental research carried out in Karaj, Iran. In this study four new commercial apple cultivars i.e. Delbarstival, Starking, Primrose and Fuji on the M.9 rootstock sprayed with GA3 and GA4+7 during the flower petal fall with two concentrations in three times. The randomized complete block design with four replications was used for statistical analysis. The treated fruits were classified according to their russetting degree. Results showed that GA4+7 has a signifi-

cant reduction in russetting of treated fruits in comparing with GA3 and control trees and there was not significant differences between GA3 and control treatment; also found that Fuji is the most sensitive cultivar to russetting and then Starking, Primrose and Delbarstival cv. were respectively.

### S11.262

#### Use of Different Methodological Approaches to Study Sugar Contents in Stonefruits

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Fruit quality is one of the main objectives of apricot breeding. In the frame of the ISAFRUIT European Integrated Project, several approaches have been used with the aim to identify the genomic regions involved in fruit quality in two important *Prunus* species. Most fruit quality traits, including sugar content, have a polygenic nature and, for an accurate QTL analysis, the phenotyping step is of most importance. To verify this aspect, several methodological approaches to study sugar contents in stone-fruit have been tested in four segregating progenies: two peach (an intraspecific F2 issued from Ferjalou Jalousia<sup>®</sup> × Fantasia and an interspecific BC2 cross derived from the peach Summergrand and the P1908 clone of *P. davidiana*) and two apricot (Goldrich × Moniqui and Lito × BO81604311, an accession derived from S. Castrese × Reale di Imola) progenies. On the fruit flesh of the hybrids of the four progenies, the total sugar content has been estimated as °Brix and the amount of the main sugars (glucose, fructose, sucrose, inositol, sorbitol) determined by proton NMR spectroscopy of flesh polar extracts. In one of the progenies (Lito × BO81604311), the content of main sugars has been determined, in addition to proton NMR, also by Gas-Chromatography (GC-FID). In this case, results have been compared and the correlation indexes determined between the two analytical strategies. Several QTLs for sugar content have been detected in the four progenies either for total sugar or single sugar contents. This accurate phenotyping evidenced once more the suitability of the use of different techniques in quantifying sugar-related compounds and how much an integrated approach is needed to dissect such complex traits in order to improve QTL identification.

### S11.263

#### Evaluation of a Soil-Applied Compound to Control Iron Chlorosis in Peach Trees: Greening and Fruit Quality

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Iron (Fe)-deficiency induced chlorosis is the main nutritional disorder of fruit trees in calcareous soils, causing decreases in growth, yield and fruit quality. Iron deficient fruit trees require continuous treatments with Fe-containing compounds through soil applications, trunk injections or foliar applications. In this experiment, we assessed the potential of a compound developed to control Fe chlorosis, in 15-year-old peach trees grown in a calcareous soil orchard under field conditions. Four treatments were applied: i) the product at a 100 g per tree dose; ii) the product at a 500 g per tree dose; iii) Fe(III)-EDDHA at a 50 g per tree dose; and iv) control (water only). Trees were flood-irrigated every 18 days. A single soil application was made on June, 3 months before harvesting, and fruit yield and quality was studied. Control trees, which were chlorotic at the beginning of the experiment, had an

atypical chlorosis development with increasing SPAD values during the experiment. This may be related to the particular environmental conditions that also delayed the appearance of chlorosis that year. When relative SPAD changes were calculated, Fe(III)-EDDHA was effective in increasing chlorophyll, the small dose of the product showed small increases, and the large dose was not effective as compared to the control. There were no differences in yield between treatments but the large dose of the product had a lower fruit number with a greater fruit size and weight than the other treatments, which could be explained by a thinning-like effect. Treatments did not have any effect on other fruit physical characteristics such as color or firmness.

### S11.264

#### Effects of Iron Deficiency Chlorosis on Fruit Quality and Yield in *Pyrus communis* L. and *Prunus persica* L. Batsch

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The effects of Fe deficiency chlorosis on yield and fruit quality were studied in pear and peach trees. Two field experiments were carried out, one in a pear orchard and a second one in a peach orchard. Iron deficiency effects on fruit size, color, firmness, acidity, vitamin C, phenolics, fruit contents of organic acids and sugars, and fruit mineral content were assessed. Iron deficiency decreased fruit yield and fruit number in both species. Highly chlorotic peach trees had smaller and less marketable fruits but a slight chlorosis increased fruit size through a thinning-like effect. Chlorosis affected fruit quality differently in each species, causing an apparent advance in ripeness in pears, with decreases in greenness and firmness, and a delay in peaches, which showed increases in firmness. Iron deficiency also caused an increase in sugar/acid ratio in pears and increases in organic acid and phenolics contents in peaches. In addition to these specific effects, an increased heterogeneity in fruit physical characteristics (size and color) was observed in Fe-deficient trees in both species.

### S11.265

#### Strategies of an Innovativeness Improvement in Fruit Supply Chains

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The poster consists of two parts. First of them presents theoretical aspects of innovativeness improvement, where strategies and activities enhancing level of creation, diffusion and absorption of innovations between entities creating fruit supply chains are emphasized. Second part presents results of the workshop conducted in Poland, where experts connected with a horticultural sector like fruit growers, processors representatives, means of productions' suppliers and policy makers, assessed the strategies and formulated conclusions concerning the effectiveness of a 'innovativeness improvement' strategies in fruit supply chains.

### S11.266

#### Investigation of Freezing Tolerance on Flower Buds of Five Peach Cultivars

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One of the problems of the peach production in Iran is winter frost injury. In this study shoots of "J.H.Hale", "Elberta", "Redhaven", "Sorkhosepfide mashhad" and "Amsden" peach cultivars were frozen for 6h at 0, -10 to -24 centigrade degree. Flower buds were tested by relative electrolyte leakage (REL) method. The randomized complete block design with three replications was used for statistical analysis. The results showed the significant differences between cultivars in all traits. According to the results flower buds of "Elberta" was the most sensitive and "Redhaven" the most resistance cultivar.

### S11.267

#### Rootstock Effects on Vegetative Growth and Flower Density of Four Commercial Apple Cultivars

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In this study, the effects of rootstocks (M9 and MM106) on vegetative growth and flower density of four apple cultivars including Gala, Fuji, Golden and Red Delicious were studied. The study was conducted on 3-year old trees, during the spring and the summer of 2009 at Research Center of Shahed University, Tehran, Iran. Number of inflorescences and flowers per trees, were affected significantly by rootstocks. Rootstocks and/or cultivars had no significant effects on Trunk diameter, Leaf area and Photosynthesis. On the other hand, rootstocks and cultivars had significant effects on Leaf chlorophyll contents. The maximum and minimum values were observed between MM106 and Golden Delicious and between MM106 and Gala respectively. Interaction between rootstocks and cultivars was also significant on one year old and current season growth shoot length, in which the maximum value was between MM106 and Fuji. However the minimum value was between MM106 and Red Delicious. Our preliminary results indicated that MM106 had more effects on scion traits than M9.

### S11.268

#### Physic-Chemical Characteristics of Peaches cv. Maciel Regarding Rootstock

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In horticulture, the use of rootstocks provides possibilities to improve the adaptability of fruit species to different conditions of climate, soil and growth systems. So, the knowledge of their effects in relation to qualitative characteristics of fruits has been required. This work aimed to evaluate the effect of the rootstocks Aldrighi, Capdeboscq, Flordaguard, Nemaguard, Okinawa and Umezeiro on peach fruit quality of the cultivar Maciel. The trial was carried out in three different agro-climate regions in the South of Brazil: Pelotas, Porto Alegre and Bento Gonçalves. In all three regions the area used for trial was 0.2ha. Tree spacing was 1.5x5.0. Experimental design was totally randomized with five trees for each rootstock and three replications. The parameters measured were total soluble solids (TSS), titratable acid (TA), flesh firmness, TSS/TA (ratio) and fruit color. Data were submitted to variance analysis with the means compared by Tukey test. In Pelotas, there was significant influence of rootstock on TA, TSS/TA and pH. 'Nemaguard' provided more acidic fruits, whereas 'Aldrighi' and 'Umezeiro' showed higher relation of TSS/TA. The fruits from trees on the rootstock Aldrighi had higher values of firmness. In the region of Porto Alegre and Bento Gonçalves, rootstock did not have any significant alteration on physic-chemical quality of the peaches exception to that 'Umezeiro' conferred redder fruits only in Bento Gonçalves region. It is concluded that the rootstock may affect some physic-chemical parameters. However, the found differences might not be completely due to rootstock effect on fruit quality, but also due to the interaction between rootstock with fruit ripening time, or pedoclimatic of each particular region.

### S11.269

#### The Influence of Harvest Date and Storage Temperature on Ripening of 'Harrow Beauty' Peaches

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The experiment was carried out in 2009 season within the activity of WP 4.2 of ISAFRUIT Project. Peaches of 'Harrow Beauty' cv. were harvested four times from 19 August until 8 September. After harvest the fruits were sorted by size and then split into three groups of approximately 160 peaches each. The fruits were weighted and then kept at three temperatures -0.5 °C, 10 °C, and 20 °C under normal atmosphere. The duration of storage was from 10 days up to 6 weeks, depending on ripening stage (harvest date) and storage temperature. At harvest and after storage the following quality parameters were measured: fruit weight, skin and flesh colour, fruit firmness, total soluble solids content and titratable acidity. Additionally, non-destructive measurements were performed using DA meter (Sintéleia, Italy) and CP Pigment Analyzer PA1101 (Control in Applied Physiology GbR., Germany). Based on collected spectra, the software offered with the equipment calculated the following indices: DA index, NDVI and NAI. The DA index is calculated using formula  $DA = A_{670} - A_{720}$ , where  $A_{670}$  and  $A_{720}$  are absorbances at respective wavelengths of 670 and 720 nm. NDVI stands for Normalized Difference Vegetation Index and is calculated as  $(I_{780} - I_{660}) / (I_{780} + I_{660})$  while NAI stands for Normalized Anthocyanin Index and is calculated as  $(I_{780} - I_{550}) / (I_{780} + I_{550})$ , where  $I_{550}$ ,  $I_{660}$  and  $I_{780}$  are remittances at respective wavelengths of 550, 660 and 720 nm. The changes of the quality parameters and the indices during fruit ripening as well as usefulness of the tested nondestructive methods for monitoring fruit ripening and quality are discussed.

### S11.270

#### Rootstocks and Root Pruning Influences the Composition and Level of Storage Rot on Apple (*Malus domestica* Bokh.) cv. Ingrid Marie in Denmark

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In an eight year old experimental apple orchard in Aarslev (Denmark) planted with a mixed population of 'Ingrid Marie' trees grafted onto rootstocks M9, B9, M26 or MM106, trees were either root-pruned on both sides in January 2009 or kept untreated. During the growing season the orchard was treated with a reduced fungicide spraying regime, and no pre-harvest treatments were applied. Five replicates of 50 fruits of the same size and weight were harvested from each of the eight combinations of rootstocks with root pruning. Fruits were stored at 2°C in normal atmosphere. Fruits were examined after 60 days of storage for the incidence of decay caused by fungi. The following storage-rot fungi were found: *Neofabraea alba*, *Neofabraea perennans*, *Glomerella cingulata*, *Nectria galligena*, *Monilia fructigena*, *Penicillium expansum* and *Botrytis cinerea*. There were significant differences of total fruit rot, ranging from 0.4% for root-pruned MM106 to 6.1% for unpruned M26. Root pruning decreased the level of decay by 88% for the rootstock MM106, 78% for M26 and 27% for M9. For rootstock B9 no significant reduction was found. The incidence of individual species of fruit-rot fungi differed between fruits from root-pruned and unpruned trees. Results of a full storage season are presented and discussed

### S11.271

#### Rootstock Tolerance to Apple Replant Disease for Improved Sustainability of Apple Production

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In 2006 a multi-location field experiment comparing the growth and yield of 12 rootstocks with and without pre-plant soil fumigation was established at 10 locations in the USA, Canada and Mexico by the NC-140 rootstock research group. Rootstocks compared were: B.9, M.9T337, M.9Pajam 2, M.26, M.7, G.11, G.16, G.30, G.41, G.935, CG.4210, CG.6210. Over the 4 years of the project there was a strong interaction of fumigation treatment and site on tree growth. At some sites the cumulative growth over the first four years was not different between the fumigated and un-fumigated plots but at other sites growth in fumigated plots was greater than in un-fumigated plots. Among rootstocks, B.9 and CG.4210 exhibited the weakest growth while M.7 had the most vigorous growth. There were no significant differences in tree size between the two clones of M.9 (T337 and Pajam2), M.26 or the three dwarf Geneva stocks (G.11, G.16 and G.41). G.935 was significantly larger than M.9 while G.30 and CG.6210 were slightly larger than G.935 but smaller than M.7. There was a significant interaction of site and fumigation on cumulative yields over 4 years. On average trees on G.935 had the greatest cumulative yield followed by G.16, G.30, CG.6210, G.11, G.41, M.9T337, B.9, M.7, M.9Pajam2, CG.4210 and M.26 which had the lowest yield. Cumulative yield efficiency was greatest for B.9 followed by G.935 G.11, G.16, M.9T337, M.9Pajam2, CG.4210, G.41, G.30, M.26, CG.6210 and M.7 which had the lowest yield efficiency. Rootstock tolerance to replant disease at each site was assessed by comparing the percentage growth and yield in fumigated plots to un-fumigated plots. Only CG.6210 showed consistent tolerance to replant disease across sites. Other stocks which showed tolerance to replant disease at some sites were G.935 and G.41. The use of tolerant rootstocks will improve sustainability of apple production.

### S11.272

#### Reducing Browning Problem in Micropropagation of Three Pear Cultivars. Sebri, Shekari and Natanz

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Natanz, Sebri and Shekari are of the best pear cultivars cultivated extensively in Iran and have an admissible consumer acceptance but have some difficulty in their propagation. *In vitro* propagation would be helpful to decrease its propagation problem. However, like many other woody plants, loss rates of explants during first stages of tissue culture process were found to be very high because of tissue phenol emersion and media browning. This study proposed to investigate effect of cultivar, culture medium, explanting time, explants type and method of browning control on browning severity of tissue and media. Shoot tip and lateral buds as explants excised during spring and summer and culture in solid MS (Murashige and Skooge) and WPM (woody plant media) after sterilization. According to the experimental result, Sebri was found more severely infected by browning. It was also found that browning intensity reached to its maximum in summer explants and mortality rates of explants exceed 95%. Browning infection in MS medium was more than WPM. Also it was founded that explants type affect browning and terminal bud had more phenol emersion and browning in comparison to second and third nodes. Finally, for remedial measures to control browning, collection of other nodes or lateral bud rather than shoot tip as explants in early spring and storage of explants in a cold (4 °C) place for 10-12 hours and 100 mg·L<sup>-1</sup> of ascorbic acid before sterilization for 15 min will be helpful in these Pear cultivars. Using PVP up to 100 mg·L<sup>-1</sup> (polyvinyl chloride) in the medium was not effective to control tissue browning *in vitro*.

### S11.273

#### Effect of Hormon Treatment and Cutting Position on Rooting of Pear Cultivars ("Sebri", "Shekari" and "Natanz") Cuttings

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An investigation was accomplished during 2007 and 2008 to test effect of hor-

monal treatment and cutting position on rooting of Sebri, Shekari and Natanz Cultivars of Pear (*Pyrus pyrifolia*). The experimental design was a two way factorial in a completely randomized method and with PGR treatment (IBA and IBA with NAA in four levels for first year and four greater levels of IBA at second year) and Position of cuttings on stem (in Two levels: terminal and basal) in three cultivar with six replication per treatment. Analysis of data for first year of experiment shown that the concentration of 3 ppm IBA was statistically increased rooting percentage and root length in both terminal and basal cuttings of Natanz cultivar. It also increased root number per cutting only in terminal cuttings of Natanz cultivar. Hormonal treatments did not show any statistically calling and rooting of Sebri and Shekari cuttings. Also observations of experiment in second year denote that basal cuttings of Sebri cultivar only in 500 mg/l IBA had a callus production of 40%. Analysis of data for this year revealed that treatment of 100 mg/l IBA induce 75% of rooting in Natanz cultivar and had the most value in both root number and root length.

### S11.274

#### Crop Load Affects Honeycrisp Fruit Quality More than Nitrogen, Potassium, or Irrigation

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Honeycrisp apple has shown extremes in fruit eating quality from in-edible to "the best apple in the world". To determine the sources of this variable quality, two field studies were planted in 2002 using Honeycrisp apple trees on M.9 rootstock. The first experiment compared four crop loads (0, 4, 8, 12 fruits/cm<sup>2</sup> TCA), soil applied nitrogen (0 and 100 kg N/ha), potassium (0 and 200 kg K<sub>2</sub>O/ha) and irrigation (none and trickle irrigation) in a factorial treatment scheme from 2002-2006. The second study compared foliar fertilizer treatments of N, B, Zn, Mg and Ca. Crop load had a negative effect on shoot and tree growth, fruit size, firmness, soluble solids and dry matter concentration. When crop load was high, fruits failed to develop characteristic flavor and color. Increasing crop load reduced storage disorders (especially bitter pit), fruit rots and percentage of bad fruits. Total crop value increased with increasing crop load up to 8-10 fruits/cm<sup>2</sup> TCA. Nitrogen soil fertilization increased fruit size, yield, soluble solids and rot incidence but resulted in reduced red color, firmness and total value of the crop in two years. Potassium fertilization increased fruit size, red color and total crop value but reduced fruit dry matter concentration. Irrigation increased shoot and tree growth, yield and fruit size but reduced fruit soluble solids and increased crop value in only 1 year. Annual water balance was positively correlated with fruit red color, size, incidence of soggy breakdown and incidence of soft scald while fruit firmness, soluble solids, bitter pit incidence and rot incidence were negatively related to water balance. Bitter pit incidence was most influenced by water balance during the early season near petal fall. Foliar nutrient sprays had little effect on tree growth, yield or fruit quality. Ca sprays reduced bitter pit incidence in only 1 year.

### S11.275

#### Chemical Composition of "Reineta" Apples from Tenerife and Bierzo

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The apple is probably the oldest tree cultivated and has been and is an important food source to humans. It is the fruit, except citrus, which can be stored for the longest period retaining much of its nutritional value. In this paper we have determined the chemical composition: moisture, ash, degrees Brix, pH, acidity, calcium, total phenols, sugars (fructose, glucose and sucrose) and organic acids (malic, citric and shikimic acids) in 120 apple samples of Reineta Blanca del Canada apple cultivar. Eighty samples were conventional (n=40) and organically (n=40) cultivated in Tenerife (Canary Island, Spain) and sampled between September and November of

2008. The 40 samples from Bierzo (León, Spain) were acquired from a supermarket in November of 2008. Official analytical methods AOAC were applied in all the determinations, except for sugars and organic acids, which were analyzed by HPLC using the methods proposed by us. Significant differences between the precedence of the apples (Tenerife and Bierzo) were found for most of the analyzed parameters. So, the apples cultivated in Bierzo showed higher ( $p < 0.05$ ) mean values of moisture, ash, pH, acidity, sucrose, maturity and mean weight than those apples from Tenerife. In contrast, the apples from Tenerife have higher ( $p < 0.05$ ) mean contents of calcium, fructose and glucose. It can be highlighted the differences in maturity and calcium. The apples from Bierzo come to market much more mature than the apples from Tenerife, and also the calcium content was considerably higher in the apples from Tenerife. Besides, important differences were observed between the conventional and organic apples. Organic apples had a higher ( $P < 0.05$ ) mean content of calcium, ash and Brix degree and lower of moisture than the apples conventionally cultivated. Applying the lineal discriminant analysis all the apple samples were correctly classified according to precedence and type of cultivation.

### S11.276

#### Effect of Crop Load on the Economic Value of 'Golden Smoothee' and 'Mondial Gala' Apple Production

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The influence of crop load on the economic value of fruit yield was studied in fully mature orchards of 'Golden Smoothee' and 'Mondial Gala', with a density of 1786 trees/ha, in Lleida (north-east Spain) over a period of 3 years. At 40-45 days after full bloom, the number of fruits/tree was counted and the trunk section area was calculated in order to induce different crop loads (2, 4, 6, 8 and 10 fruits/cm<sup>2</sup>). Each crop load level was replicated on 6 different trees. We recorded standard fruit quality (firmness, soluble solids content, starch index and fruit disorders), fruit yield in each marketable category and return bloom in the following year. We also calculated income for each control tree. Finally, we studied the evolution of each of these parameters according to crop load. No effects on the starch index and firmness were observed. However, we did notice a tendency for soluble solids content and acidity to decrease related with higher crop loads, especially with 'Mondial Gala' apples. In the case of 'Golden Smoothee', we observed a tendency for the incidence of bitter pit to increase with low crop loads. In both cultivars, higher crop loads were associated with reduced return bloom. Under our conditions, the optimum crop load level for 'Golden Smoothee' to achieve the highest income was around 5.5 fruits/cm<sup>2</sup>. For 'Mondial Gala', we obtained larger fruits with more color when the crop load was lower and the crop load level that produced the highest income was around 3.5 fruits/cm<sup>2</sup>.

### S11.277

#### Effect of Different Soil Moisture on Phenolic Compounds Content of "Red Fuji" Apple

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The aim of this paper was to study the effects of different soil water content on the content of phenolic compounds in Red Fuji apple. The three soil moisture levels, 50-55%, 65-70% and 80-85% (percent of maximum field capacity), were designed as the experiment treatments. Fruits were collected on the 70 DAFB (day after full bloom) and 178 DAFB. The contents of total polyphenols, procyanidin, chlorogenic acid, epicatechin, catechin, rutin and coumaric acid in fruit flesh and skin were measured. The total polyphenols content in the flesh and skin at 178DAFB was significantly lower than that at 70 DAFB. The total polyphenols content in skin was higher than that in flesh at two times. The three soil moisture treatments had no significant influence on the total polyphenol content in the flesh at two times and in skin at 70DAFB, but it was significant lower in skin at 178DAFB with 80-85% treatment than that with other treatments. The three soil moisture treatments had little influence on the content of proanthocyanidin in skin but had significant effect

on it in the flesh. The content of proanthocyanidin in the flesh at 70DAFB with 50-55% treatment was significantly higher than that with other treatments, while it was the highest with 80-85% treatment in the flesh at 178DAFB. The contents of chlorogenic acid and catechin in the flesh and skin at 70DAFB with 50-55% treatment were higher than that with other treatments, while the content of epicatechin with 80-85% treatment was the highest. The contents of chlorogenic acid and catechin in the flesh and skin at 178DAFB with 80-85% treatment were the highest.

### S11.278

#### Ethylene Controlling Agents in Pre- and Post-Harvest to Control Post-Harvest Diseases in Pome Amd Stone-Fruits

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Aminoetoxivinil glicine (AVG) and 1-metilciclopropene (1-MCP) interfere with the ethylene metabolism by reducing its biosynthesis/emission or by blocking its cell receptor, respectively. More in details AVG was applied on nectarine (Stark Red Gold) and pear (Abbè Fetel) while 1MCP was tested on apple (Red Delicious) and kiwifruit (Hayward). These two compounds were tested for their ability in reducing ethylene emission and in controlling post-harvest diseases incidence and severity. Both AVG and 1-MCP allowed to preserve the fruit quality traits during a prolonged shelf-life and, at the same time, resulted in a reducing of some post-harvest diseases (scald, *Monilinia*, *Botrytis* and *Penicillium* rots). In particular, AVG applied 15 to 7 days before the expected harvest showed an interesting control on *Monilia* and *Penicillium* and its effect was comparable with the one of well known resistance inducers such as the jasmonic acid derivatives. On the other hand, 1-MCP controlled scald occurrence Red Delicious apple and its efficacy was related to fruit ripening stage: 1-MCP was effective when applied in preclimacteric stages while on the contrary no effect was found when fruits were harvested during the climacteric. Finally, post-harvest treatments with 1-MCP significantly protected kiwifruits from *Botrytis* mould.

### S11.279

#### Evaluation on Fruit Bearing Habit of Sweet Cherry Cultivars on "Dwarf Gisela" 5 Rootstock

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The sweet cherry cultivars B.Burlat, Nalina, Sunburst, Summit, Regina, Kordia, Lapins, Katalin and Hudson were planted in 2001 on dwarf Gisela 5 rootstock. During 2007 and 2008 we evaluated the age of bearing wood with spurs on above mentioned cultivars. Our results show that more than 50% of flower buds on spurs were situated on two years old wood for Sunburst, Regina, Kordia, Lapins and Katalin. For B.Burlat, Nalina, Summit and Hudson the spur type of buds were on 3 years old one. The flower buds on spurs were relatively high on 5 and 4 years old wood for cvs. B.Burlat, Nalina and Hudson. No flower buds on 5 years old wood for Kordia and on 6 years old one for Katalin. On 7 years old wood no flower buds for all sweet cherry cultivars under our evaluation. On the base of our results we separate the 9 cultivars in two groups concerning the percentage of flower buds on different age of bearing wood.

### S11.280

#### Infrared Spectroscopy Used for the Fruit Quality Characterisation of Apricot Hybrids from a Cross between Two Contrasted Cultivars

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This work reports the rapid determination of apricot fruit quality traits using near (NIR) and mid (MIR) infrared reflectance spectroscopy. The FT-NIR (800-2500 nm) spectra were acquired on intact fruits (diffuse reflectance), whereas the FT-MIR (4000-650 cm<sup>-1</sup>) spectra were acquired on fruit slurries using a horizontal ATR cell (Attenuated Total Reflectance). Relationships between spectral data and quality attributes obtained by traditional methods were evaluated in 2006 on about 180 hybrids coming from the crossing between 'Goldrich' and 'Moniqui' apricot cultivars. The non-destructive method using NIR spectroscopy allows the prediction of soluble solids content and titratable acidity with errors of prediction of 6.8% and 13.9% respectively. The ATR-FTIR performed on apricot slurries is well-adapted for the prediction of the individual compounds: sucrose, glucose, fructose, malic acid and citric acid (errors of prediction inferior or equal to 14.3%). The PIR and MIR models established in 2006 have been used in 2007 for the prediction of quality traits of the same 180 hybrids.

### S11.281

#### Research Regarding the Behavior of Some Species of Apple in Super Intensive Orchard, in Campia Romana

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Campia Romana is not a traditional area for apple culture in Romania. Recently, apple culture has begun to extend in southern regions, by ensuring irrigation water. The present study presents the partial results obtained in a super intensive apple plantation, established in 2005, with planting distance of 3,5/1,5 m. Eleven varieties of apple, grafted on M9, with different fruit maturity periods were tested. As far as vegetative growth is concerned 3 varieties (Elstar, Florina and Mutsu) were more vigorous, while Delbard, Jonathan and Granny Smith varieties were less vigorous. The ramification capacity was higher for Sir Prize, Mutsu and Liberty, which formed more branches and a thicker trunk, but Granny Smith, Elton and Jonathan ramified less and formed a thinner trunk. The precocity given by the parent stock was expressed by the quite high production in the fourth year since plantation, having provided between 16,2 and 19,3 t/ha, and in the 5th year between 29,1 and 32,6 t/ha. The quality of the fruits was very high; more than 80% of the fruits were within extra and first class.

### S11.282

#### A House of Quality for a Sustainable Fruit Sector: a New Tool for the Verification and Promotion of Consumer Orientation in Applied Fruit Research

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The ISAFRUIT 'Vasco da Gama' process (VdGp), launched in March 2008, aims to provide a science-based method for relating horticultural technology-oriented research, to consumer demand related research and vice versa. In particular, it should allow a scientifically sound assessment of how pre- and post-harvest research carried out in ISAFRUIT addresses the demands of consumers. This as-

essment can be used to verify that ISAFRUIT research will directly contribute to the project's goal of increasing fruit consumption in Europe. In addition to demonstrating the strength of the research being done, the VdGp can be used to identify essential knowledge gaps in horticultural technology development, which is valuable for targeting future research. The "reverse engineering" methodology applied as part of the VdGp, is based on a tool called the "House of Quality" (HoQ). A HoQ is normally used in new-product development processes to determine which characteristics are necessary to outperform competitor products in meeting consumer demands. In the version adopted in the VdGp, technical attributes for fruit quality are related to attributes representing consumer demands for fruit. 'Vasco da Gama' was a Portuguese explorer who commanded the first ship from Europe to India, thereby bridging different continents and cultures. The process is named after him because his achievements metaphorises how social and natural scientists are working together in the VdGp, to create a common understanding and terminology that can be used to link results generated from their two disciplines. A webpage has been established to provide updates about the state of the art of the VdGp and the ISAFRUIT House of Quality: [www.go.warwick.ac.uk/vasco](http://www.go.warwick.ac.uk/vasco). Here we present the scientific background, specific case studies and the potential of the method.

### S11.283

#### Sweet Cherry Cultivar, Rootstock and Training System Interaction

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Oregon sweet cherry growers are now producing numerous cultivars of varying productivity. Fruit quality among commercial producers has varied widely depending on the productivity of the cultivar, the chosen training system and the rootstock. In this study, 'Regina', 'Bing' and 'Sweetheart' represent cultivars of low, moderate and high productivity, respectively. Each cultivar is combined with three different rootstocks (Mazzard, MaxMa 14 and Gisela 6). In addition, 'Sweetheart' and 'Regina' were evaluated on Krymsk 5 (VSL2) and 'Regina' on Krymsk 6 (LC52) rootstocks. All cultivar/rootstock combinations were grown on three common training systems grown in Oregon, a spindle system known as "Vogel Central Leader", a multi-leader bush system known "KGB" and a triple axe system known as "Steep Leader". This study evaluates tree precocity, tree size (trunk cross sectional area), fruit yields, fruit size as well as management time studies for each training system. Four years of yield and other data will be presented.

### S11.284

#### Crop Load Effects on the Cellular Dynamics of Apple Fruit Growth

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Studies were conducted on fruit growth of Red Delicious and Gala apple over two years. Two crop loads were imposed on trees: moderate/heavy crop load (little to no thinning) and light crop load achieved by thinning soon after bloom. Collection of fruit samples began one week after bloom and continued at approximately weekly intervals until harvest. Fruit size and cortical cell size was measured and cortical cell number estimated. In most cases fruit from lighter cropped trees had fruit over 40% larger than those from more heavily cropped trees. The growth curves of Red Delicious and Gala overlapped and the only reason Red Delicious fruit were larger at harvest was due to their later harvest date. Cell size was not influenced by crop load. In both years of the study, cell numbers increased rapidly for 40 days after flowering, and there was little increase after this time. There were common positive relationships between cell size and fruit size throughout the growing season, but there was no such relationship when only the samples close to harvest were considered. With samples close to harvest there were strong positive relationships between cell number and fruit size indicating crop load affects on final fruit size were mainly due to increased cell numbers rather than increased cell size.

### S11.285

#### Effects of Different Tree Densities on Some Important Characteristics in Apple Fruit cv. Granny Smith

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Increasing the tree number at hectare caused to higher efficiency in many plants. In this study, for determine the best density, apple tree cv. Granny Smith (grafted on M-26 rootstock) was cultivated at four densities included: 1904 tree/hect, 2666 tree/hect, 3555 tree/hect and 4800 tree/hect and some important characteristics were measured. Results indicated that the highest and the lowest performance obtain at 4800 tree/hect and 1904 tree/hect respectively. But in spite of suitable efficiency, Fruits produced in higher density had low weight and low size in contrast with fruits produced in lower density. Also, determination of K, Fe, Ca, P and Ethylene production rate showed that in high density compared to low density fruits had lower quality and were prone to incidence of storage disorders. The total peel chlorophyll measurement indicated that, reduction of tree per hect resulted in improved fruits appearance. No significant differences were observed in four densities according to Mg and fruits Firmness. Therefore, higher tree density caused to increasing of efficiency but with reducing of fruit quality. According to this study for producing suitable Granny Smith apple with acceptable fruit quality, density of 3555 tree per hect was recommendable in Karaj region of Iran.

### S11.286

#### "Symbio" as an Example of Network Organization in a Horticultural Sector

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Symbio Poland is organising production, processing, distribution and trading of organic fruits, vegetables, herbs and grains to the local and international markets, resulting in more wholesome food for consumers, biodiversity preservation of land and value for Symbio stakeholders. The way of Symbio<sup>2</sup> functioning in a managerial literature is called "virtual network", where coordinator undertakes a few core activities but manages all others through partnership and outsourcing contracts. Symbio as an example of "virtual network" can be treated as an organizational innovation in a horticultural sector. The poster presents the way of coordination and management the main processes in the network, e.g. building strong relationships with suppliers and customers, creation a raw material base by recruiting and helping fruit growers with shifting from a conventional to organic production etc. The way of coordination of processes of the whole network innovativeness improvement is depicted as well. In order to make evident an effectiveness that kind of organization, which helps with gaining new markets and improve performance of network<sup>3</sup> entities, some financial results are presented.

### S11.287

#### Combination of Optical and Mechanical Techniques for the Measurement of Maturity and Firmness in Red Soft-Flesh Peaches ('Richlady')

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The main objective of the present research is to explore the relationship between non

destructive (ND) measurements (impact and optical) and maturity, referenced by the date of harvest. Peach trees (*Prunus persica*) produce staggered fruit maturation, so that high variability is expected for a certain harvest date. ND average values for each date are used as a reference. So far the destructive Magness Taylor Firmness (MTF) was compared to ND measurements. Data from just harvested fruits from two seasons, n=311 and n=400, were considered in this analysis. These fruits corresponded to 3 and 5 harvest dates respectively. Principal Component Analysis (PCA) and multilinear regression for MTF estimation were applied using the following ND measurements: 1. The mode of each Red/InfraRed image histogram was computed and used as a continuous variable, expected to be related with maturity and firmness. 2. Optical indexes computed from spectral local (0.5 cm<sup>2</sup>) measurements recorded with Minolta spectrophotometer. Indexes proposed earlier to study peach ripeness on hyperspectral images were evaluated (Chlorophyll related indexes: Ind1, Ind2, Ind3, IAD). 3. Low impact response: Maximum Impact acceleration, Time for max. Acceleration, Impact hardness: slope between Max.Impact acceleration / Time for max acceleration, Maximum deformation. PCA was performed and by considering two principal components (80.4% of variance), two main factorial directions, optical (Opt) and mechanical (Mec), were identified. MTF was projected on the first PCA plane and was explained 62% by the Opt direction and 40% by the Mec direction. The quality of representation of MTF on the PCA plane was 70%. A multilinear regression between MTF and Opt and Mec variables was also performed and showed a good linear relationship for the range of 20N-80N. Results obtained showed that these two groups of variables (Opt and Mec) were able to explain maturity variations.

### S11.288

#### Feasibility of Using Chromatic Indices for Quantification the Color and Quality of Apricot Cultivars

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In apricot fruit, establishing the optimal harvest time is crucial, since fruit quality potential are closely related to the ripening stage at harvest. Stage of maturation is usually estimated by fruit color through parameter L\*, a\*, b\*. The goal of this study was establish feasibility of different chromatic indices for apricot color and quality determination and their relationship with pigments and ethylene concentration. Color changes during apricot ripening were the result of significant changes in the values of a\*, h°, (a\*/b\*)<sup>2</sup>, (1000a\*/L\*b\*), (180-h°/L\*+C\*). Chroma and lightness were not good parameters to express apricot ripeness because narrow range of variation and small differences between stages of maturation and even between varieties. Relationship between a\*/b\*, L\*, C\* and total carotenoids content were very weak. For ripened apricot fruits a\*, h°, chromatic indices could be used as objective ripening indices.

### S11.289

#### Orchard Management: Differences between the Integrated and Organic Apple Production

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During the Isafruit project the orchard management of four integrated and four organic farms were observed in the lower Elbe region for three years. The farmer concerned has the opportunity to get detailed data of the yield and of the costs of their own orchards. From advisor point of view weak points of the farm management could be pointed out and improved to get the optimal fruit quality and yield to increase the rate of return. Nowadays it is very important for fruit growers to get very exact data of their orchards. During this project additional data of the organic apple orchards could be determined. The Results of Clever & Görgens (2006) that on average the yield of the organic orchards was 30% lower than of the integrated orchards could be confirmed. In spite of lower yields and higher losses during storage, organic farmers get twice higher producer prices and therefore higher proceeds. Beside the yield depending harvest costs, organic farms have higher labour costs

because of more manual work due to the lack of chemical pesticides. Altogether the four organic orchards had lower labour cost because of smaller need of working hours for harvesting, grading and storing due to lower yields.

## S11.290

### Cultivar Comparison with the Managerial-Economical-Tool "Arbokost"

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One of the most important strategic decisions for fruit growers is the cultivar choice. Apple cultivars have different prices, different grading results and different yield. Those three factors are ones influencing most the labour income entrepreneur. With about 500 to 600 labour hours per year and hectare it's a very manpower intensive culture. The yield and grading are the most time intensive work within the apple production. Both of them are influenced by the cultivar and are very important factors too. By choosing the right cultivars, grower can reach economical success with their orchard. Using that information we set up a new version of the managerial-economical software-tool for fruit growers "Arbokost". This tool reflects a full cost account, the cash flows during the orchard life time (15 years), and the earned income for each year and other different key data which are important to evaluate the apple production from an economical point of view. With the new version growers can compare simultaneously five plots (with different cultivars) by introducing year by year the key data, yield and grading hours they got. With "Arbokost" growers can also make simulations to evaluate new apple cultivars by introducing information about key data and expected working hours. The cultivar choice is furthermore a difficult decision to take. With "Arbokost" growers have more information to take the right decision for their orchard and to control systematically the apple cultivars they already have.

## S11.291

### Effects of Spraying Selenium on the Pear Fruit Quality

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Selenium (Se) is an essential element in the human diet. Spraying with Se could yield Se-enriched fruits. The aims of this study were to investigate the effect of spraying Se on fruit quality of pear (*Pyrus pyrifolia* L var. 'Dangshansu'). Pear plants grown in field culture were sprayed with sodium selenite (0, 1, 3, 5mg/L) two times at the period of fruit enlargement. The results showed: Fruit weight and size on average of Se-treated pear plants were improved and fruit shape index were highest at 5mg/L sodium selenite. The lower Se concentration could increase the fruit firmness, TSS (total soluble solid), reducing sugar, TSS/TA (the content of titratable acidity), Se treatment resulted in higher sucrose, total soluble sugars, pectin and lower titratable acidity, Vitamin C. The content of sclereid bigger than 0.05mm were decreased by spraying selenium, but the content of sclereid smaller than 0.05mm were increased besides 3mg/L Se treatment. According to these data, spraying 3mg/L sodium selenite is the suitable concentration for improving the fruit quality of 'Dangshansu' pear cultivar. As a Se source in human diet, the quality of Se-enriched fruit in other fruiters was discussed.

## S11.292

### Influence of Smartfreshsm on Firmness, Soluble Solids and Acidity of Apples cv. Elshof, Champion and Topaz Following Storage and Shelf Life

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The influence of the ethylene inhibitor 1-methylcyclopane (SmartFreshSM) on fruit quality of the apple cultivars 'Elshof', 'Shampion' and 'Topaz' grown in Denmark, Germany and Poland was investigated as a part of ISA-Fruit WP4.2 to provide data for developing and testing the Decision Support System (DSS). Apples were harvested at two harvest dates for each of two years, fruit were either treated with SmartFresh or untreated and were held in long time storage under CA-conditions as recommended for each cultivar. Destructive samples were taken five times during the storage period and fruit quality was assessed after shelf life (7 days at 18 °C). All fruit treated with SmartFresh remained firmer than control fruit but this was especially significant for apples cv. 'Elshof' produced in Denmark. Following shelf life SmartFresh treated fruit cv. 'Shampion' had an increased sugar content relative to control fruit and the acid content of 'Elshof' in Denmark, and 'Shampion' and 'Topaz' in Poland were higher than for their respective control fruit.

## S11.293

### Identification of Transcriptional Signatures Associated with Apple Fruitlet Abscission

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Apple (*Malus domestica* L. Borkh) represents an interesting model tree crop for studying fruit abscission. The physiological fruitlet drop occurring in this species can be selectively magnified by using thinning chemicals, such as benzyladenine (BA). Despite the economical importance of thinning process, aimed at obtaining fruits with improved quality and marketability, the molecular determinants of apple fruitlet abscission are still unknown. In the present research, BA was used to obtain fruitlet populations with different abscission potentials that were analysed by means of a 30,419 oligonucleotide microarray. The apple microarray was set up starting from about 256,000 expressed sequence tag (EST) sequences available in public database. A dedicated bioinformatic pipeline was created to cluster and assemble the available ESTs into tentative unigenes that were spotted by means of the CombiMatrix technology. RNAs were extracted from cortex and seed of apple fruitlets sampled over a 4-day timecourse, after triggering fruit drop with BA treatment, and used for microarray hybridisation. Transcriptomic profiles of persisting and abscising fruitlets were tested for statistical association with their abscission potential, allowing to identify molecular signatures strictly related to fruit destiny with  $P < 0.001$ . The molecular markers herein discovered may be used as diagnostic tools for the early identification of the self- or chemical-thinning aptitude of apple cultivars. Moreover, the functional characterization of genes with the best statistical scores will allow to shed light on the early molecular processes underlying apple fruitlet abscission.

## S11.294

### Flower Bud Inhibition of European Plum with GA3 Application to Manage Crop Load and Overcome Alternate Bearing in a Nordic Climate

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Crop load adjustments in European plum trees (*Prunus domestica* L.) by hand or chemical thinning are required to achieve marketable size, fruit quality and to overcome alternate bearing. Efficient tools for crop load management are strongly needed, since only a few chemical thinners are registered and hand thinning is costly. Gibberellic acid (GA3) was tested as a novel approach to regulate the crop load of the plum cultivar Opal at Ullensvang, western Norway. The objective was to reduce flower bud induction in the "off-year" and therefore adjust crop load in the subsequent year. In 2008, an off-year, GA3 was applied to 9 year-old 'Opal'

trees as a high volume spray to running off at 50 ppm and 100 ppm, 5 weeks after full bloom, 10 weeks after full bloom, both dates and compared with untreated control trees. The trees were unthinned the first year and thinned to commercial standard the year after. In the year of application, total yield was recorded and fruit quality evaluated. Return bloom, fruit set, yield and fruit quality was assessed in the subsequent season. Generally, there was no significant difference in crop load of all treated trees compared to untreated trees in the year of application (non target crop). Only fruit weight increased slightly, when early applied compared to untreated trees. The following year (target crop) the fruit set was significant reduced for all GA3 treatments. The most effective was the early application. The crop of the thinned fruitlets was largest for the untreated and the late application. The crop load reflected the fruit set. The fruit weight and fruit colour increased significantly from the lowest cropping trees. There was no effect on fruit firmness. GA3 is an efficient tool to inhibit flower bud induction and therefore to manage crop load.

### S11.295

#### Scab-Resistant Apple Cultivars for Juice Production

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During three years experiment 26 scab resistant apple cultivars were processed into juices using laboratory method of juice extraction. 'Shampion' and 'Antonovka' were the control. The purpose of this experiment was selection of cultivars suitable for juice/concentrate production. Considering possibility of both clear and cloudy juice production juices were pressed with and without mash enzymation. Juices were investigated for pressing yield, titratable acidity, soluble solids and sensory characteristics. Apple cultivars studied showed wide variability in investigated parameters. During experiments some cultivars were found valuable for concentrated apple juice production due to high acidity or soluble solids content or both these parameters. Cultivars suitable due to high acidity were: 'Reglindis', 'Antonovka', 'Rewena' and 'Renora'. Very high soluble solids content was found in 'Regina' and 'Topaz' (above 14%). Several cultivars had more than 13,5% soluble solids ('Enterprise', 'Shampion', 'Rubinola', 'Gold Milenium', 'Renora' and 'Rebella'). Those rich in soluble solids had high juice density - usually above 1.055 (correlation coefficient above 0.90). There was no correlation between soluble solids and acidity content and no correlation between acidity and juice density. 'Regina', 'Topaz', 'Enterprise', 'Shampion', 'Renora' and 'Rebella' were the 6 cultivars most suitable for concentrated juice production considering content of soluble solids and acidity. Some cultivars were very interesting due to sensory characteristics and balanced soluble solids to acidity ratio. These were: 'Shampion', 'Gold Milenium', 'Rajka', 'Melfree' and 'Ariwa'. Average values for 3 years indicate that all cultivars fulfilled requirements of the Code of Practice of the European Fruit Juice Association concerning chemical composition. In single years there were some deviations.

### S11.296

#### QTL Analysis for Fruit Ripening Traits in Apricot (*Prunus armeniaca* L.)

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For many consumers fruit quality is the factor which predominantly impacts their consumption of fresh fruits. Fruit quality is dependent on numerous parameters, but, in apricot, the large genetic variability observed among cultivars, and the major difficulties in keeping the maturation under control are among the most important. In numerous breeding programs, phenotyping methods during the field evaluation phase are now well established; however, the molecular bases of fruit maturation have been poorly investigated except on model fruit such as tomato. It is the reason why the identification of genomic regions involved in apricot maturation has been

targeted as part of the ISAFRUIT WP6.1 European IP Project, mainly based on the genetic and molecular characterization of fruit quality traits in peach, apricot and apple fruits. An apricot F1 population of 120 offsprings has been constituted from a cross between two parents contrasting for their maturation features: 'Goldrich' (large, firm, orange fruit with a slow evolution during ripening, before and after picking), and 'Monique' (mean, soft, white fruit with a very rapid evolution). The parents and the hybrids were characterized for fruit maturity date, firmness (pressure), colour (H°), and ethylene production during two consecutive years. An SSR-based genetic linkage map anchored to the general map for *Prunus* was established for each of the parents and QTL analyses were performed for all the investigated quality traits. A very large variability was observed in the hybrid population for all the investigated traits. Several QTLs were detected in both genetic maps for all the analyzed traits, except fruit firmness: maturity date, fruit colour and ethylene production. QTL stability was stated between years and the influence of the parent genetic backgrounds was clearly established. Consequently, interesting opportunities are then offered for apricot breeding in using markers associated to the main QTLs in a MAB process.

### S11.297

#### Effect of Twelve-Month Storage on the Content of Polyphenols and Vitamin C in Osmo-Dried Fruits

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Osmo-freeze-dried (OFD) and osmo-convectively dried (OCD) fruits were manufactured from apple, sour cherry and blackcurrant. Concentrated fruit juices, sucrose, fructooligosaccharide and invert sugar concentrates were used as osmotic agents. Products were stored at 18°C for one year and tested for the nutrients during storage. A gradual decrease in total polyphenols occurred in OCD fruits. The largest decrease (up to 45%) was in blackcurrants. Anthocyanins were most labile; 80-90% of delphinidin-3-rutinoside was lost after one-year storage. Anthocyanins in OCD sour cherry were particularly unstable, approx. 80% of these compounds were lost after three months. Retention of chlorogenic acids in OCD sour cherry amounted to 60-80% after a year. Polyphenols in OFD fruits were more stable. Approx. 75% of initial polyphenols were present in blackcurrants after twelve months, over 60% in sour cherries, 60-90% in apples. No tendency towards a decrease in the content of chlorogenic acids and anthocyanins in apples was observed. Cyanidin-3-glucosylrutinoside and cyanidin-3-rutinoside constituted the main fraction of sour cherry anthocyanins. Their contents were almost unchanged after storage. At least 80-90% of chlorogenic acids present in OFD apple was determined after one-year storage. In the case of OFD blackcurrants anthocyanins were the dominant fraction; delphinidin-3-rutinoside was the polyphenol occurring in the highest amounts and showing good stability. OFD blackcurrants were characterized by the highest content of ascorbic acid, which was relatively stable under the storage conditions (68% retention). OCD blackcurrants contained 2-3 times less vitamin C than lyophilizates. Its stability was also lower for OCD material (decrease by approx. 80% after a year). In the case of OFD apples, initial ascorbic acid content was lower than that of blackcurrants. The highest was for apple osmo-dehydrated in blackcurrant juice; after a year there was a decrease by 32%.

### S11.298

#### Possibility of Cloudy Plum Juice Production

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Plums are a rich source of antioxidant compounds, such as phenolic acids (neochlorogenic acid, chlorogenic acid), anthocyanins (cyanidin-3-rutinoside, cyanidin-3-glucoside) and other flavonoids. Polyphenolic compounds have a potential therapeutic role related to cardiovascular diseases, cancer treatment, cataract, Parkinson's disease,

Alzheimer's disease or ageing of the organism. Plums are characterized by an excellent taste and dietary properties. Unfortunately, consumption of this species is rather seasonal and not very common. To increase intake of this valuable fruit technology of cloudy plum juice production was developed at the Research Institute of Pomology and Floriculture. The subject of investigation was cloudy plum juices obtained from plum cultivars: 'Wegierka Dabrowicka', 'Promis' and 'Cacanska Najbolia'. Juices were produced on semi-technological scale using rack and cloth press. In experiment macerating enzyme combinations were used with activity of pectin lyase and polygalacturonase in the ratio 2:1. The most important chemical parameters of juices were determined: soluble solids, total acidity, turbidity, anthocyanins content and total polyphenols content. Addition of ascorbic acid (AA) in quantity of 500 mg/kg had protective effect on anthocyanins. In control juice average anthocyanin content was 53±55 mg/L while in juice with AA addition anthocyanin content was even 92 mg/L. The prerequisite for obtaining high quality plum juice is selection of a proper cultivar. Ripeness degree also plays an important role in obtaining product with acceptable sensory characteristics, which should have a balanced proportion of soluble solids to acids. Out of the tested cultivars the best results were obtained with cv. Cacanska Najbolia. After gaining a positive result in semi-technological scale the experiment was carried out in processing plant Alpex Sp z o.o., without major technological problems.

### S11.299

#### Impact of Thermal and Non-Thermal Drying Processes on Polyphenol Retention in Apple Snacks

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The regular consumption of fresh or processed fruits contributes to welfare by preventing cardiovascular diseases, diabetes and some types of cancers, particularly thanks to micronutrients with anti-oxidative properties, naturally presents in fruits. Fresh apples are an important source of polyphenols (up to 1500 to 4000 mg/kg for cider apples). Consumers' increasing interest for fruit snacks, considered as healthy, shows the importance to pay more attention to potential health-protecting compounds in such new product development. Nevertheless, precise knowledge on the impact of processing on antioxidants preservation is scarcely available. In this study, dehydration impregnation by soaking (DIS) and convective drying have been studied both separately, and combined. Their impact has been followed through ascorbic acid and polyphenol losses kinetics. Apple fruits (*Malus domestica*) of 6 dessert and cider cultivars were chosen for their different antioxidant contents and their different compositions in polyphenols. Ascorbic acid content and polyphenol profiles were measured by HPLC, for different times and processing temperatures, versus moisture and sucrose contents. The behaviour of ascorbic acid during DIS appeared very different from the one during convective drying: it disappeared sharply during DIS, but remained quite stable during drying at 45 °C, with only a progressive decrease in concentration (dry basis) with removal of moisture. Polyphenols were much better preserved by all processes and even better by convective drying. Sucrose impregnation had no impact on polyphenol retention during convective drying, but allowed to hide the astringency of the procyanidins. Data exhibited temperature dependence with a higher retention at 45 °C than at 60 °C for DIS, and different behaviours depending on the polyphenolic groups of compounds. Procyanidins were better preserved by DIS than hydroxycinnamic acids. This latter group of polyphenols was soon involved in enzymatic browning, but could also diffuse more easily as their molecular weight was lower.

### S11.300

#### 'Sunrise': A New Early Maturing Fire Blight Resistant Pear Cultivar

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'Sunrise' is a new pear (*Pyrus communis* L.) cultivar released by the Agricultural Research Service, U. S. Department of Agriculture. It combines a high degree of

resistance to fire blight with excellent fruit quality. The sources of resistance in the pedigree are the old American cultivar, 'Seckel' and NJ1, a *P. communis* × *P. pyrifolia* hybrid. It matures in early August in the northern hemisphere, approximately 2 weeks before 'Bartlett' and one week before 'Clapp's Favorite', and is characterized by a storage potential and shelf life greater than the cultivar 'Clapp's Favorite'. Precocity and production was similar to 'Bartlett', as is average fruit weight. The cultivar is moderately resistant, but not immune, to pear scab, but susceptible to powdery mildew and Fabraea leaf spot. Fruit infection with Fabraea is minimal.

### S11.301

#### Selection of Iranian Early Apple Cultivars Based on Genetic Storage Potential

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This research was computed on 7 very early to mid-early Iranian cultivars grown in Karaj (Tehran province) pedoclimatic conditions, in 2007. The fruits were picked both in ripening phase and physiological maturation time. Based on moderate storage capacity of early ripening classes, we proposed hypothetically three different storage life of 4, 8 and 16 weeks programming pomological tests and sensorial analyzes in weekly, biweekly and 4 weeks temporal intervals. The samples were stored in cold condition at 0±5 °C and 80±5 % humidity. In each interval following characters weight, TSS, TA, flavor index, firmness, aroma, taste and general acceptability were accurately measured. Comparing the results of different harvest times, it was noted that the cultivar storage efficiency may be fully expressed if harvest time would overlap adapt phenological phase of growth meaning just before climacteric phase beginning or just after fruit physiological maturation. Even in not expected humidity conditions of the cold room, we observed a range of cold storage capacity of 4 to 12 weeks conserving quality, external characters and general acceptability of sensorial analyzes.

### S11.302

#### Properties of Selected Apple Genotypes

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Studies of the more prominent pomological properties of selected seedlings were carried out on seven seedlings in parallel with cv. Granny Smith of which seedlings were obtained by free fertilization. Examinations were conducted in the orchard of PKB "Vocarske Plantaze Bolec" (in the vicinity of Belgrade). The seedlings were selected among 104 studied ones according to the pronounced properties. Selection was done on the basis of fruit properties (largeness, size, chemical composition and ripening time). Six selected seedlings have ripening time of winter apple cultivars (seedlings registered as II/34, I/2, IV/13, II/28, III/11), while the seedling IV/9 is of summer ripening time. The selected seedlings of later ripening time ripened, on average, a week earlier than cv. Granny Smith. The summer ripening time seedling (IV/9) had lower fruit weight than cv. Granny Smith, while seedlings of winter cultivars ripening time had higher fruit weight than cv. Granny Smith. The seedlings I/2 and I/28 have significantly higher content of fruit soluble dry matter than cv. Granny Smith, and other selected seedlings had the same content level of fruit soluble dry matter as cv. Granny Smith. The selected seedlings also differ from parent cv. Granny Smith in fruit skin color.

