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Nordic Association of Agricultural Scientists

NJF Seminar 391

Fruits and Berries: New crops and new uses.

- Non-traditional production and utilisation of fruits and berries

Kristianstad, Sweden, 18-20 September 2006

NJF
Nordic Association of Agricultural Scientists

SWEDISH UNIVERSITY OF AGRICULTURAL SCIENCES
SLU

The initiative to organize this seminar came from the working group “Fruit” of NJF section III “Horticulture and Landscape”.

The organizing committee has consisted of:

Asdish Helga Bjarnadottir, Iceland
Stein Harald Hjeltnes, Norway
Hanne Lindhard, Denmark
Irmelin Nyman, Finland
Birgitta Svensson, Sweden (local organizer)
Madeleine Uggla, Sweden (seminar secretary)

Nordic Association of Agricultural Scientists
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NJF Seminar 391

Fruits and Berries: New Crops and New Uses

Non-traditional production and utilisation of fruits and berries

September 18-20, 2006

The Swedish University of Agricultural Sciences
Department of Crop Science at Balsgård,
Fjälkestad, Kristianstad, Sweden

Day 1: 18 September 2006

8.30 -	**Bus transport from hotels**
8.30 – 10.00	**Registration/Poster mounting** **Coffee**
10.00 – 10.20	**Welcome Address Tomas Lundborg**
	ORAL PRESENTATIONS **Chairperson**: Hilde Nybom
10.20 – 11.10	**Health in fruits and berries** Key Note Speaker: Klas Sjöberg
11.10– 11.30	**Extracts from organically and conventionally cultivated strawberries inhibit cancer cell proliferation in vitro** Staffan Andersson
11.30 – 11.50	**New and untraditional berries in teaching and research at the Norwegian University of Life Sciences** Finn Måge
11.50 – 12.10	**Suitability of raspberry and blackcurrant cultivars for utilization of frozen berries in dessert and for getting of products with high contents of bio-active compounds** Kaspars Kampuss
12.10 – 12.30	**Summing up of oral presentations and discussion**

12.30 – 13.30	**Lunch**
	ORAL PRESENTATIONS **Chairperson:** Hanne Lindhard Pedersen
13.30 – 14.20	**Berries – Challenge for Food Industry** Key Note Speaker: Jussi Hautala
14.20 – 14.40	**Cool climate viticulture – a new field of research and teaching in Denmark** Torben Toldam-Andersen
14.40 - 15.00	**Changes in tocopherols and carotenoids during ripening in rose-hips and sea buckthorn berries** Staffan Andersson
15.00 – 15.20	**Simulation and nutritional aspects of processing fresh rose hip** Ingegerd Sjöholm
15.20 – 15.40	**Summing up of oral presentations. Discussion**
15.40 – 16.30	**POSTER SESSION** **Soil and plant borne fungal diseases in Swedish strawberry fields** Ulrika Carlson-Nilsson **Fungal resistance in Swedish dogroses** Ulrika Carlson-Nilsson **Domestication of the cloudberry: soil, NPK fertilization and cultivars** Kalle Hoppula **Special berries to the market – a development project cutting the local agro-food chain** Ville Korpelainen **Towards a healthier apple – chemical characterisation of an apple gene bank** Hilde Nybom **BRu 9804-3, a new Swedish promising primocane raspberry selection** Bo Sjöstedt **How to predict and control chemical status of *Vaccinium myrtillus* L. berries** Andreas Åkerström **RAPD-estimated genetic diversity in 15 lingonberry (*Vaccinium vitis-idaea*) populations** Larisa Gustavsson

16.30– 18.00	**Visiting fields and laboratories at Balsgård**
18.00	**Bus transport to hotels**
18.00 – 20.00	**NJF Working Group Meeting**

Day 2: 19 September, 2006

8.30	**Bus transport from hotels to Balsgård**
	ORAL PRESENTATIONS **Chairperson**: Nina Heiberg
9.10 – 10.00	**Soft fruit production – A general overview and international trends** Key Note Speaker: Magnus Engstedt
10.00 – 10.30	**Coffee**
10.30 – 10.50	**Nordic fruits and berries – very rich sources of beneficial phenolic antioxidants** Kimmo Rumpunen
10.50 – 11.10	**Activities in rose hips, an overview** Madeleine Uggla
11.10 – 11.30	**Dogrose (*Rosa* section *Caninae*) studies at Balsgård, past and present** Gun Werlemark
11.30 – 12.00	**Summing up of oral presentations. Discussion**
12.00 – 13.10	**Lunch**

ORAL PRESENTATIONS
Chairperson: Magnus Engstedt

13.10 – 14.00	**From new plants to commercial crops** Key Note Speaker: Nina Heiberg
14.00 – 14.20	**Genetic diversity in recently domesticated fruit and berry crops** Hilde Nybom
14.20 – 14.40	**Japanese quince (*Chaenomeles japonica*) – a promising productive organic fruit crop** Kimmo Rumpunen
14.40 –15.10	**Coffee**
15.10 – 15.30	**Sea buckthorn – cultivation and harvest method at Torslunda Research Station, Sweden** Ingrid Björklund
15.30 – 15.50	**Strawberries and raspberries in tunnels, experiences from Rånna Experimental Station, Sweden** Birgitta Svensson
15.50 – 16.10	**Lingonberries (*Vaccinium vitis-ideae*), – the red gold of Sweden** Larisa Gustavsson
16.10 – 17.00	**Summing up or oral presentations. Discussion** **Closing remarks**
17.00	**Bus transport to hotels**
19.00	**Bus transport from hotels to restaurant**
19.30	**Seminar dinner**
23.00	**Bus transport to hotels**

Abstracts

Day 1

NJF seminar No 391: Fruits and berries: New crops and new uses. Non-traditional production and utilisation of fruits and berries: Sweden, 18-20 Sept 2006

Health in fruits and berries

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More than 1/4 of the American population is obese. Today we have just as many (1.2 billion) that suffer from starvation as are suffering from overweight. The prevalence of diabetes will increase from 150 million today to 350 million in less than 20 years. In Sweden more than half of the adult population has overweight and more than half of our teenagers eat too much fat and not enough with fruit and vegetables. Already around 10% of the Swedes have the metabolic syndrome, i.e. pre-diabetes, and two of overweight, hypertension and/or high blood lipids.
A healthy diet is the corner stone in a healthy life and possibly a long life expectancy. Low intake of fruit and vegetables is included in the top 10 list of risk factors for global mortality. 2.7 million lives can be saved annually, for example 31% of ischemic heart disease. An increased intake reduces blood pressure, leads to a better glucose control and reduces the risk for cancer, where 1/3 is thought to be caused by the diet. Several research reports have documented a wide range of health effects. Intake of antioxidants such as flavonoids reduces the risk for cardiovascular disease with 35%, a high intake of apple, onion and grape reduces the risk for lung cancer with 40% and the risk for asthma is reduced already after an intake of 2 apples a week. Extracts of rosa canina reduces pain in arthrosis, have antibacterial effects and inhibit cancer cell growth. Blueberries also have anticarcinogenic effects and enhance memory, at least in rats. WHO estimates that 30% of all cancer, 90% of diabetes and 80% of all cardiovascular disease can be prevented by better food habits, no smoking and enough with exercise. Measures have to be taken soon if we want to influence the global health, especially as it now is the developing countries that risk to develop our welfare diseases.

NJF seminar No 391: Fruits and berries: New crops and new uses. Non-traditional production and utilisation of fruits and berries: Sweden, 18-20 Sept 2006

Extracts from Organically and Conventionally Cultivated Strawberries Inhibit Cancer Cell Proliferation In Vitro

Marie E. Olsson, Staffan C. Andersson, Stina Oredsson, Rakel H. Berglund, Karl-Erik Gustavsson*

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The effects of extracts from strawberries of cv. Honeoye, grown in both organic and conventional production systems, on cancer cell proliferation in vitro were investigated. The content of several antioxidants in the strawberry extracts were analysed and compared with the inhibition effect on cancer cell proliferation. The strawberry extracts inhibited cell proliferation in colon cancer cells HT29 and breast cancer cells MCF-7 in a concentration dependent way. Extracts from organically grown strawberries inhibited cell proliferation to a higher extent than conventionally grown at the two highest concentrations. This might indicate that the content of secondary metabolites with anticancer properties were higher in the organically grown strawberries. There were great differences in the content of the analysed antioxidants between the two cultivation methods. The content of ascorbate was 36% higher and the ratio of ascorbate to dehydroascorbate were eight-fold higher in the organically grown strawberries than in the conventionally grown, whereas the content of ellagic acid, total anthocyanidins and total phenolics were lower. No significant differences were found in the content of hydroxycinnamic acid and flavonols between the two production systems. The higher content of ascorbate found in the organically grown strawberries might have affected the higher inhibition of cancer cell proliferation by the extracts from the organically produced strawberries compared to the conventionally grown strawberries. Ascorbate is suggested to act synergistically with other substances in the extracts.

Presented at:
International Symposium on Human Health Effects of Fruits and Vegetables, 2005, Québec, Canada.

NJF seminar No 391: Fruits and berries: New crops and new uses. Non-traditional production and utilisation of fruits and berries: Sweden, 18-20 Sept 2006

New and untraditional berries in teaching and research at the Norwegian University of Life Sciences

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In our part of the world, the struggle for life is not the same as the struggle for food any more. We are looking for specialities, and when people find something exclusive, they are willing to pay the price. Many of our students are more interested in new crops or niche crops, than in traditional food plants. Also the agricultural politics in Norway have appealed to produce new products, or small-scale products to support the traditional agriculture, and give some extra income to the farmers.

For about 15 years ago, we started a student course at UMB on new plants and new plant products in horticulture and agriculture. The course turned out to be very popular, and about 300 students have so far had a taste on those subjects. We included several fruits and berries in the course, both about production, new products, and also some about marketing. Agricultural plants, vegetables, flowers and spices were included. The main aim of the course was to get ideas, to learn to think of untraditional products, ant to tell growers about the possibilities.

At the experimental farm we established plantings with several plants, and we have had regular experiments with some of the species. New berries included were black chokeberry (*Aronia melanocarpa*), elderberry (*Sambucus nigra*), saskatoonberry (*Amelanchier alnifolia*), jostaberry (*Ribes* x *nidigrolaria*), japanese quince (*Chaenomelis japonica*), sea buckthorn (*Hippophae rhamnoides*), rose hip (*Rosa* spp), all-fieldberry (*Rubus articus* L. Subsp. x *stellarticus*), cloudberry (*Rubus chamaemorus*). In addition the course includes wild berries like blueberry (*Vaccinium myrtillus*), cowberry (*Vaccinium vitis-ideae*), cranberry (*Vaccinium oxycoccos*) and *Sorbus* spp. Of cultivated berries minor species like garden blueberry (*Vaccinium corymbosum*), gooseberry (*Ribes grossularia*), blackberry (*Rubus fruticosus*) and red currants (*Ribes rubrum*) are included. Also growing berries outside ordinary season, domestication of wild blueberry and cowberry, and about sugar production from *Acer saccharum*, and from birch (*Betula* spp.) is discussed.

Much of the education materials are found from the literature, and much experience comes from our own plantings. A compendium is prepared, and we have written several articles in grower magazine about new berry plants.

What about results? The many students having joined this course are now spread all over Norway. We see more and more small-scale products, especially on farmers marked, farm outlets, and on fairs. We hope that local small-scale products also will be sold in ordinary food shops. We like to think that our efforts for about 15 years have given results.

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Suitability of raspberry and blackcurrant cultivars for utilization of frozen berries in dessert and for getting of products with high contents of bio-active compounds

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Many different blackcurrant and raspberry cultivars are recommended for commercial growing in Latvia. Unfortunately, neither commercial nor other cultivars are tested for suitability frozen storage and production of different products, including functional foods. Moreover, most of cultivars, well examined and demanded by Western European processing companies, cannot be grown in Latvia because of different climate. Therefore frozen berries of 15 raspberry and 32 blackcurrant cultivars, grown at Latvian Fruit growing institute, Dobele, Latvia, were tested for chemical composition (ascorbic acid, anthocyanins, soluble solids) and physical properties (drip loss and friability for raspberries, berry weight for all berries). Agronomical parameters (productivity, winter hardiness, disease and pest hardiness) were included in an overall evaluation of cultivars as an average from experts' estimates. Multi-criteria analysis (Мартинов, 1987) was used to establish a complex value of genotypes. The analysis allows comparing the complex values of different genotypes, using various parameters in different measurement systems. Each trait group and individual trait has specific contribution coefficient in the final evaluation. The best variety will appear to be as close as possible to the desired (optimum) value in parameters as many as possible. Multi-criteria analysis was performed to select the best cultivars for utilization of frozen berries in dessert and in production of product with high contents of bioactive components. The most suitable cultivars for utilisation berries in dessert are raspberry cultivars 'Tomo', 'Brigantina' and 'Bryanskii Rubin', and blackcurrant cultivars 'Detskosel`skaya', 'Yadrenaya', 'Joniniai', 'Chernii Kentavr', 'Selechenskaya' and 'Mara'. They were conspicuous with big berries and low acid/sugar ratio as well as with little drip loss after thawing and low friability level in frozen raspberries. The most suitable cultivars for utilisation berries in production of products with high contents of bioactive components: ascorbic acid and anthocyanins, are raspberry cultivars 'Sputnitsa', 'Ariadne', 'Bryanskii Rubin' and 'Brigantina' and blackcurrant cultivars 'Iyunskaya', 'Detskosel`skaya', 'Vernisazh', 'Vakariai', 'Triton', 'Titania' and 'Joniniai'.

Martinov, S.P. 1987. Metod mnogokriterial'nogo bibora na zaklyuchitel'nom etape selektsii rastenii (in Russian). Мартинов, С.П. 1987. Метод многокритериального выбора на заключительном этапе селекции растении. Сельскохозяйственная Биология, 6, 122 – 124.

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Berries - Challenge for Food Industry

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The food market is currently rapidly changing. Healthy, functional, low energy food is becoming more and more popular. Many Food companies are developing new products to this segment. Food Industry is chancing to Wellness Industry. Berries fit basically well to this trend. Much scientific data has been produced to document the beneficial effects of berries. Still more is needed and consumers should be made aware of those results. Popularisation of scientific data is needed in order to prepare the market. In Nordic countries berries have higher status than elsewhere. Stamp of "exotism" lays on many berries as close as at European main markets (France, Germany, UK). This has its positive and negative sides. Generally can be stated that only a small part of the population is easily accepting new ideas quickly – even if news are positive.
After market is identified the need has to be fulfilled - every day during the year even fresh raw materials are available only for short time. This means that Industry has to produce whole years unpredictable need in short period or raw material has to be kept available for whole year. Economically storage of raw material is cheaper than keeping final products in stock.
This stock has to keep quality. Freezing is traditional method but aseptic pure, pure concentrates, juice concentrates and dehydrated formulations etc. are usually easier for processing. Nordic countries could be better in this area. Investments and Innovations for added value are needed. Tailored semi fabricates are interesting solution for processing Industry. Availability and quality have also to be stable year after year. This is a challenge for whole chain. Weather we cannot influence, but what about tolerating weather?

Price is a critical issue. Most tropical and European fruits are today much cheaper than Nordic berries. Most of them can also be produced in countries where cost level is lower than here. Either Nordic price have to meet better the competition or local berries have to find profile, which gives clearly higher status on market. Labor cost in Nordics is so high that special arrangements with harvesters or effective mechanization of harvesting is necessary. High status can also push the price level nonreachable for Food Industry. This is a risk now with blueberries in shortage situation where Pharmaceutical Industry is able to pay prices, which consumers are not accepting in food basket.

Constant high quality has to be met. Food Industry is based on hazard analyses (HACCP). This is more and more coming to raw material sourcing. Critical risks have to be identified and solutions provided. We are not only talking any more about taste, smell, colour and structure. Risks with microbiology, chemical residues, allergens, parasites, radioactivity, heavy metals, foreign bodies (also from raw material itself like seeds, stems, pieces of skin), GMO, natural toxic substances and so on have to be evaluated, measured, and documented. Research is needed also on this side - not only on positive matters.

There is seldom constant quality without traceability. Processor has to be able to show the origin of each lot. Keeping traceability is quite a challenge if lots have to be built up from many small units.

Close cooperation, long-term commitment, tailored solutions, contract growing with win-win attitude brings best results.

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Cool Climate Viticulture, a new crop in research and teaching in Denmark

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Since 1999 Denmark has been registered as a wine producing country in the European Union. About 30 commercial growers have established a production and a total production of about 50.000 bottles are expected in 2006. Both red, white, rose and sparkling wines are produced. Wine has for many years been produced in Denmark from cherries and apples but the production based on grapes is new. New cultivars and a milder climate in recent years support the development. At Pometet a cultivar collection was established in the early 1990'ies and has developed over the years to comprise almost 100 cultivars suited for cool climate viticulture. At Pometet we aim to show different production methods both for open field production and in more protected environments such as plastic tunnels and small scale unheated greenhouses. In the teaching student projects have been the initial activities within viticulture dealing with aspects of plant physiology, fruit development and flowering habits. In 2006 the area was developed further with a new course 'Cool Climate Viticulture and Enology' initiated in cooperation between 3 associate professors at different departments at KVL. The teachers covers the whole spectrum from viticulture, postharvest and fruit quality to microbiology ie fermentation processes. Furthermore, the teaching expertise is expanded with 8 days in Germany with excursions and teaching at the University and Research Station in Geisenheim. The course is a 5 week intensive course aimed at students in both horticulture and food science and so far with great success, as 17 students from 7 countries studying horticulture, agriculture, food science, food technology as well as human nutrition followed and passed the exam in June.

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Changes in tocopherols and carotenoids during ripening in Rose-hips and Sea Buckthorn Berries

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Rose-hips and sea buckthorn berries have high contents of carotenoids, tocopherols and other antioxidants, which are considered to have beneficial health effects. Antioxidants are antagonists against free radicals and other reactive oxygen species which have the potential to damage cell components such as DNA, lipids and proteins. However, data about genetically determined variations in amounts and types of different vitamins and antioxidants in rose-hips and sea buckthorn berries during ripening are scarce. In this work berries from 4 different genotypes of roses and 4 different sea buckthorns during the ripening period were analyzed for their content of carotenoids and tocopherols. The results show a great difference of the analysed compounds and the time of harvest, as well as between the different genotypes. This indicated a great potential to influence and/or increase the content of antioxidants in foods containing rose-hips and sea buckthorn berries, by choice of species, cultivars and harvesting time.

Presented at:
27th International Horticultural Congress & Exhibition, 2006, Seoul, Korea

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Simulation and Nutritional Aspects of Processing Fresh Rose Hip

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Products from rose hips are very popular in Sweden and good representatives for commercially traditional food consumed as a soup or fruit ingredient in yoghurt and healthy beverages. Fresh rose hips, 100 g edible part, contains around 270 mg vitamin C and the recommended daily intake in Sweden is 60 milligram. During processing as blanching, drying and freezing the water-soluble nutrients as vitamin C will be affected and by then reduced.

The aim of this project is to better understand how to optimise the drying process of rose hips and at the same time retain the nutrients at high level. The influence of different drying air temperatures, air velocities and drying times are investigated in order to find the kinetics of degradation of vitamin C and other water soluble bioactive components in rose hips.

The results of drying *R. rubiginosa* and *R. dumalis* can be concluded as follows:

1. It is possible to dry rose hips in slices and retain 75% of vitamin C.
2. Simulation of the drying procedure follows traditional drying theory. More investigations must be done to simulate the kinetics of reduction of vitamin C.
3. The degradation of water soluble nutrients are all taking place during the first part of the drying when the water activity is close to 1.0.
4. The content of vitamin C and other measured water soluble nutrients are not further affected after the reduction of vitamin C in the very first part of the drying.

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Poster

Soil- and plant borne fungal diseases in Swedish strawberry fields

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Many strawberry growers in Sweden have problems with soil- and plant borne fungal diseases. As the information of the presence, distribution, and prevalence of this kind of diseases in Swedish strawberry farms is very sparse a survey was made in 2003. About 100 strawberry farms at various locations in Sweden were visited from August to October. The number of farms from each district was in proportion to the total area cultivated with strawberries in the same district. To be able to observe any possible differences in the presence of fungi in conventionally grown strawberries compared to ecologically grown, samples were also taken from ecological farms.
A visual inspection and a preliminary diagnosis was made at each farm whenever possible. Each grower gave information about the origin and age of the plants, chemical treatments of plants etc. Twenty-five plants (=one sample) from one cultivar were then collected at each farm and sent for laboratory analysis to *Växtskyddslaboratoriet i Skandinavien AB*. Material from each sample was grown on agar medium and analysed with PCR or ELISA for the identification of possible pathogens. Mainly species of *Phytophthora*, *Rhizoctonia*, *Verticillium* and *Colletotrichum* were studied.

The most common disease found was *Phytophthora cactorum*. *Phytophthora fragariae* on the other hand, was only found in one sample. *Rhizoctonia* spp. was the second most common disease. In one sample we found *Colletotrichum acutatum*. As this was the first documented case of this disease in Sweden, a new sample was taken one year later in the same field and sent to another laboratory to confirm the diagnosis. The cultivar infected was 'Kimberly' which is known to be sensitive to this disease. The only soil- and plant borne disease to be found in the ecologically grown strawberries was *Phytophthora cactorum*.

The cultivars 'Honeoye', 'Kimberly', 'Korona', 'Polka', 'Dania', 'Zefyr', 'Florence' and 'Pegasus' were represented in the survey. 'Dania' and 'Honeoye' were most sensitive to *Phytophthora cactorum* and *Rhizoctonia* spp. was found on these two cultivars as well as on 'Polka'.

A small greenhouse inoculation test with *Phytophthora cactorum* was performed as well. Relatively large cultivar differences in resistance were shown. 'Senga Sengana' was most resistant among the included cultivars whereas 'Dania' was very sensitive.

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Fungal resistance in Swedish dogroses

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Blackspot, leaf spot, powdery mildew and rust are common fungal diseases in roses. Several cultivars are sensitive to one or more of these diseases. In the production of rose hips it is important to be able to keep fungal infections at an acceptable level. For example, large attacks of blackspot often decrease the winter hardiness of the rose plant. Some wild species however, appear to be more tolerant to the diseases.
In a study at Balsgård, seedlings of five dogrose species were screened for leaf spot in an experimental field. Apparently seedlings of *Rosa rubiginosa* are less affected by leaf spot compared to the other species in the study. In a greenhouse inoculation study, *R. dumalis, R. rubiginosa* and *R. villosa* were infected with a polysporous inoculum of *Marssonina rosae* causing blackspot. The *R. rubiginosa* genotypes were the least affected, with mean values below 12% infected leaves. In another study, hybrid seedlings from crosses using *R. dumalis* and *R. rubiginosa* as pistillate parents and selections from section *Cinnamomeae* as pollen parents, were assessed in a field trial. Infections of powdery mildew and rust were rare whereas blackspot and leaf spot were more common. Significat diffeences between families with different staminate parents were found for blackspot, leaf spot and powdery mildew, indicating the possibility to select for resistance in seedlings from crosses involving section *Caninae*.

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Poster

The domestication of the cloudberry – soil, NPK fertilization and cultivars

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The cloudberry (*Rubus chamaemorus* L.) is one of the most valuable wild berries in Fennoscandia. Great yield variation and lack of pickers encumber the activity of the industry. The domestication of the cloudberry would assure the berry supply because the factors affecting yield variation would be controlled better in fields.

In MTT Sotkamo research station, the prerequisites for cloudberry cultivation were studied from 2001 to 2004 in field trials. The measures were a part of the project "Lakka 2002-2004" ("Cloudberry 2002-2004") funded by EU Interreg IIIA Karelia programme and carried out by ProAgria Kainuu and MTT Sotkamo.

The three trials introduced here, soil trial, NPK fertilization trial and cultivar trial, were established in MTT Sotkamo in August 1999 as a part of the project "Lakan (*Rubus chamaemorus* L.) viljely- ja kantavalintakoe 1999-2000" ("The cultivation and variety trial of the cloudberry (*Rubus chamaemorus* L.) 1999-2000") funded by EU Interreg IIA Karelia programme and carried out by ProAgria Kainuu, MTT Sotkamo, and the University of Kuopio.

In the soil trial, the cloudberry growth and yield were studied in four different soil mixtures. In the NPK fertilization trial, the effects of three levels of N, P, or K, respectively, were studied. In the cultivar trial, four Norwegian cultivars were compared.

The best soil for the cloudberry was a 1:1 mixture of *Sphagnum fuscum* (Schimp.) Klinggr. and light sphagnum peat. The cloudberry growth in mineral soil (fine sand) was poor. In two other treatments, 1:1 mixture of fine sand and *Sphagnum fuscum* and 1:1 mixture of fine sand and light sphagnum peat, the growth was intermediate.

Fertilization with N, P, or K did not affect cloudberry yields. However, until 2003, the fertilization did affect the vegetative growth. In 2004, the best shoot density, approximately 600 shoots per square metre, was reached with a planting year soil N content of ≥600 mg/l, P content of ≥30 mg/l, and K content of ≤200 mg/l. These nutrients were only applied separately. Interactions were not studied.

In the cultivar trial, cultivars Fjellgull (female), Fjordgull (female), Apollen (male) and Apolto (male) were compared. The most yielding female cultivar was Fjellgull. No differences in vegetative growth were observed.

In these trials, practical preliminary results for cloudberry cultivation were achieved. However, the ecology and physiology of the cloudberry are still mostly unknown, and more research is needed.

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Poster

Special berries to the market – a development project cutting the local agro-food chain

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”Special berries to the market” (originally in Finnish “Erikoismarjat markkinoille”) is a project whose purpose is to develop the local berry industry in the Kainuu region in the eastern Finland. The main emphasis is on the cultivation and product development of wild berries, especially cloudberry (*Rubus chamaemorus* L.), cranberry (*Vaccinium oxycoccos* L.), arctic bramble (*Rubus arcticus* L.), and wild strawberry (*Fragaria vesca* L.). The project covers the whole know-how chain from the ecology of natural habitats through domestication and cultivation to food production and health effects.

The total funding of the project is 381.980 €. The project is funded by the Euregio Karelia Neighbourhood programme (45 %), Council of Oulu Region (45 %), and private funding (10 %) including Maiju and Yrjö Rikala Horticultural Foundation, the Scientific Foundation of Finnish Association of Academic Agronomists, and enterprises including four nurseries and eight berry farms. The time frame of the project is from 2005 to 2007.

At the beginning of the know-how chain, the Friendship Park Research Centre of the Kainuu Regional Environment Centre collects information from the cloudberry’s and cranberry’s natural habitats. This includes data of flowering and yielding in the different habitats, frost hardiness, and sexual distribution and variation of cloudberry flowers.

Next, MTT Agrifood Research Finland’s Sotkamo research station has the responsibility of the cultivation trials and the collation of cultivation knowledge. The trials include cultivar trials of natural and bred clones, simple farm trials of cultivation techniques (e.g. pest management and fertilization), and cloudberry trials of soil physics and soil biology.

Compositions of bioactive compounds in berries are investigated in the Laboratory of Biotechnology, Kajaani University Consortium, University of Oulu. In the analyses, total phenolic compounds, anthocyanins, flavonols including myricetin and quercetin, carotenoids, seed oils (fatty acids), vitamin C, fibres, organic acids, and proteins are studied. The results will be utilized in marketing and product development.

Finally, ProAgria Kainuu Rural Advisory Centre (project manager Mrs Heli Pirinen) leads the project and has the responsibility of knowledge transfer. In addition to those, ProAgria Kainuu has the main role in the cooperation with the enterprises and in the development of marketing and products.

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Towards a healthier apple - chemical characterisation of an apple gene bank

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Apple cultivars in a Swedish gene bank were evaluated for content of phenolic compounds, the Mal d 1 allergen and two sets of DNA markers.

The analysed cultivars differed considerably in content of total polyphenols determined in apple skin; 5710-26180 µg GAE/g dm (GAE=gallic acid equivalents) with an average of 13950 µg GAE/g dm, as did also the major phenolic compounds (range in µg/g dm); quercetin-3-rutinoside 0-720, quercetin-3-galactoside 60-2290, quercetin-3-glucoside 20-1770, quercetin-3-xyloside 80-970, quercetin-3-arabinoside 180-2160, quercetin-3-rhamnoside 30-3440, catechin 0-1630, procyanidin B2 100-4380, epicatechin 60-3700, phloridzin 30-2840 and chlorogenic acid 15-3590. The average content of phenols, the range in content of each phenolic compund and the coefficient of variation was consistent between years in 99 cultivars analysed in two successive years. The correlation coefficient was also high between years for each of the phenolic compounds studied. Therefore it is possible to develop new cultivars with high content of specific polyphenols by crossing traditional cultivars and making use of the existing variability.

Amount of Mal d 1 was determined by Western analysis in freshly harvested fruits and in fruits stored for 2-8 weeks. Apple skin had a higher concentration than the fruit flesh in freshly harvested fruits. During storage, amount of allergens increased both in the skin and in the fruit flesh. Considerable differences were found between cultivars in initial amount of Mal d 1 and in the development during storage. Preliminary results for the cv. Aroma also suggest an influence from time of harvest and storage conditions. More analyses are, however, needed to define the role of different environmental factors, and to ascertain their generalization to other apple cultivars.

Establishment of DNA marker profile for the chemically investigated cultivars with RAPD and SSR loci enabled unambiguous identification of the plant material as well as estimation of genetic relatedness among genotypes. Shannon index-based estimates of genetic variability were surprisingly similar when different subgroups of the material were compared (old 0.580, medium 0.585 and recent cultivars 0.566), and Swedish 0.576, other European 0.583 and non-European 0.543). Moreover, cluster analyses show little grouping associated with geographic origination, suggesting that there has not been much large-scale differentiation among the studied cultivars.

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BRu 9804-3, a new Swedish promising primocane raspberry selection

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As foreign primocane raspberry cultivars showed to have a too late ripening time in the Swedish climate a breeding program was established at Balsgård, Swedish University of Agricultural Sciences, in 1982. In 1988 one of the raspberry selections from this breeding program, BRu 8302-2, was hybridized with tayberry (raspberry x blackberry). This hybridization resulted in only one hybrid, BRu 88/1605-1. The expected chromosome number was 4n = 28 as the raspberry was diploid and the tayberry hexaploid. However, chromosome analysis showed that, for unknown reasons, the hybrid was only 2n = 14. Nevertheless, it showed morphological characters from both raspberry and tayberry. The chromosome number was very suitable regarding future hybridizations with other diploid raspberries. The hybrid had very large berries (average weight 6.0 g), but as it was hard to harvest the selection had to be improved. In 1995 it was used as a pollen parent and was hybridized with the cultivar 'Autumn Bliss'. One of the hybrids was BRu 9505-18 which had very short canes (30 cm) and therefore not easy to harvest. This selection was open pollinated in 1998 and it resulted in the seedling BRu 9804-3 with several good qualities. This selection will be named 'Electra'. It has erect, moderately thorny and self supporting canes of 1.0 – 1.4 m. The berries are dark red, conical and very large (30 x 20 mm) with an average weight of 6.0 g. They are firm and easy to harvest. In a three year trial in southern Sweden the average yield was 2.5 kg per plant. The flavour is very aromatic and suitable as a dessert berry as well as for industrial purposes.

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How to predict and control chemical status of*Vaccinium myrtillus L.* berries

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The high interest in bilberry as functional food and for production of medical products has increased the demand for high quality berries. This has awakened ideas of domestication and development of management practises for production are essential. A reliable method to predict quality parameters such as antioxidant (anthocyanin) content of berries would greatly improve the possibilities for farmers and berry industries to produce and keep high-quality products. Furthermore, more information regarding optimal habitat requirements (for high quality purposes) would ease the decision of when to pick berries or where to establish bilberry cultivation. While the market is expanding, only 4% of the wild berry production is harvested each year. Moreover, the cost for harvesting is increasing year by year. It is therefore of great interest to evaluate if intensive agricultural production of this species is possible in northern Sweden, under what conditions and to what economical cost.

This PhD-project aims at evaluating the possible advantages on food quality when growing bilberry in northern Sweden. In addition, the ability to grow bilberry as a commercial agricultural crop will be evaluated. The studies deal with gathering information about how chemistry of berries, mainly anthocyanins are affected by different abiotic conditions.

Hopefully, the results from this project will give farmers and entrepreneurs in the region of Eastern Norrbotten advantages due to the latitudinal based requirements and high commercial value of this new product. The initial cost to establish a plantation is rather high. However, as bilberry is a perennial plant and has low requirements of additional nutrients to produce good yields and berries of high quality, the production cost in a longer perspective will be economically sustainable. Combined with easy on-farm processing (drying, labelling and packaging,…) a bilberry farm can be easily managed and labelled as an “organic farm”, sustainable from both an economical and environmental point of view. Besides contributing to rural development the additional values from on-farm processing and organic farming would let small farms escape the cost-prize-squeeze of modern economics. Moreover, establishment of costal bilberry farms would also reduce the long transports that the berry industry is facing today and may reduce the need of additional handling between farmer and industry.

However, for successful rural development, there has to be a force of will within the local community. A willingness to work, and not just for the own farm but for the region as a whole, to start networks and local distribution chains, and to help and support each other.

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RAPD-estimated genetic diversity in 15 lingonberry *(Vaccinium vitis-idaea)* populations.

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Lingonberry, *Vaccinium vitis-idaea* is a perennial evergreen dwarf shrub, which grows preferably on acid soils in coniferous forests and bogs. Traditionally lingonberries have been picked from native wild stands in Swedish forests, but domestication was initiated in the 1960s. Plant breeding of lingonberry is still at an early stage. In order to broaden the genetic basis and to improve some horticulturally important traits, we must optimize sampling strategy and thus also need information about genetic diversity and genetic structure of wildgrowing populations.

RAPDs markers were used to assess the genetic diversity in 15 lingonberry populations, assembled from Sweden, Finland, Norway, Estonia, Russia, Japan and Canada. Cluster analysis revealed a geografic grouping of populations in most cases. Mean within-population diversity was 0.431 when estimated with Shannon's index and 0.206 when estimated with Lynch and Milligan index. The values are in agreement with the mixed mating system reported for lingonberry. Most of the genetic variability (68.6%) resided within populations. Based on the results of a RAPD analysis and the application of a computer program designed to maximize genetic diversity, 69 individuals were selected for preservation in a gene bank at Balsgård.

Abstracts

Day 2

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Soft fruit production – A general overview and international trends

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The production of soft fruit for the fresh market is undergoing a big change because of many reasons: reduction in available pesticides, demand for residue-free fruit, healthy image, changes in cultivation e.g. tunneling and season extension, market decides cultivars, new cultivars but also resistance-breaking strains of pests and diseases. We will see an increasing demand for the future.

Also the production of soft fruit for processing will have more focus on healthy aspects. The number of products will undergo a dramatic change for the future. Before establishing new plantings growers should always secure there is a link to an end producer. Growers in all countries has this responsibility. If not, things will happen like in Poland. An uncontrolled production will take place and the world market price will fall dramatically far below production cost.

My vision is that the big environmental profits will be gained by the conventional growers who step by step are changing in direction to organic farming. In Strawberry for example the Swedish conventional growers has adopted quite a big use of physiologically active agents against P&D, biological control, damage threshholds, monitoring and control systems and decision support systems. They are on the way, but there still is along way to travel.

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Nordic fruits and berries – very rich sources of beneficial phenolic antioxidants

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Fruits and berries are excellent sources of dietary fiber, vitamins, and minerals, but they also contain different phenols that may provide significant health benefits, e.g. prevent cancer and heart disease, and contribute with antioxidants. Especially different berries have in several studies, mostly based on a limited number of samples, been reported to have high content of phenols and high antioxidant activity. However, few studies have investigated the diversity within species. In this paper we will report preliminary results confirming that sloe (blackthorn, *Prunus spinosa*), rose-hip (*Rosa* sp.), purple chokeberry (hybrid black chokeberry, *Aronia x prunifolia*), dewberry (*Rubus caecius*), chaenomeles (*Chaenomeles* sp.), bramble (blackberry, *Rubus* sp.), elderberry (*Sambucus nigra*) and bilberry (*Vaccinium myrtillus*) have very high content of antioxidant acitivity that correlates with the total content of phenols. The phenotypic variation in total antioxidant activity may be up to four-fold among cultivars and species.

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Activities in rose hips, an overview

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Roses belong to one of the most popular groups of ornamental plants both for the beauty and fragrance but roses has also been known for the utilisation of the fruits, rose hips. Rose hips, especially from species within section *Caninae* and to lower extent also section *Cinnamomeae* have a long tradition in several countries as raw material for tea, jam and juice but they are seldom consumed fresh. In Sweden the traditional product of rose hips is the rose hip soup. Recently there is also an increasing international interest for the bioactive compounds in rose hips. In 2004 the first International Rose hip conference was held in Gümüshane in North Eastern Turkey (Nybom & Rumpunen 2005). The Swedish domestication project of rose hips was initiated twenty years ago, aiming development of cultivars for commercial growing. Apart from the plant breeding work, it was necessary to develop suitable agronomic practices, methods for assessing fruit quality, and estimate the need for pest and disease resistance (Uggla 2004).
An overview over activities in rose hips, from different countries as well as in Sweden will be described.

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Uggla, M. 2004. Domestication of wild roses for fruit production. Doctoral thesis, Swedish University of Agricultural Sciences. Agria 480.

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Dogrose (*Rosa* section *Caninae*) studies at Balsgård – past and present

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Balgård, Swedish University of Agricultural Sciences (SLU) located in the south of Sweden, first became involved in dogroses in 1985. Together with a Swedish food manufacturer, Balsgård developed new varieties of dogroses for production of rose hip soup. A huge collection of dogrose species from all the Nordic countries was executed and new crosses both within the section and with species from other sections were performed. On the collected material and on the crossings, several studies have been performed with both morphological characters and molecular markers as well as on the contents in the rose hips. The dogroses have a very peculiar meiosis with uneven distribution of genetic material from the egg cell and pollen cell, respectively, which could complicate further plant breeding. Therefore, it has been vital to study the odd canina meiosis in detail. Further, it is always necessary to know what kind of variation you have when you start a domestication program. The variation within and among the dogrose species has therefore been studied very closely. And since the main objective to start with, was production of rose hips for the food industry, it was also necessary to find the most suitable genotypes. These three main lines of studies will be presented along with prospects for future studies.

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From new plants to commercial crops

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It is an increasing demand for new tastes and innovative food. The result can be seen in every supermarket as an overwhelming number of new products. The demand for "healthy" food has increased the consumption of fruit and berry products, but unfortunately, the fruit and berry growers in the Nordic countries have not benefit much from that. In Norway, the consumption of fruit and berries has increased from 53 kg per person in 1995 to 67 kg per person in 2005, but the part of Norwegian grown products has decreased from 7 to 3 % (Rebnes G. 2006). Very few of the new fruit and berry products originate from the Nordic countries. We have to make a long-term strategy to change this. This strategy should include introduction of new plants as well as development of new products of well-known plants.

There are a series of characteristics that a new fruit or berry plant must have if it is to ever make the large jump from botanical curiosity into commercial crop. These include agricultural, industrial and marketing characteristics. It should be easy to propagate, productive, be easy to harvest, and fit into current farm practice. The product must be easy to transport and store, and if necessary, to process. It should also be able to enter an established market at a competitive price or should be so attractive that a new market can be easily created. It is a long-term work; there are few cases of instant success in the introduction of new crops. The first stage should involve a study of the suitability of the new crop, as frequently, a species shows it optimum behaviour under a limited range of environmental conditions. A critical aspect deals with the use of sufficient genetic variation. Many attempts to adapt a new crop to a new region has failed because of the use of limited genetic variation. Another key point is to identify growing techniques that can improve the productive potential of the new crop. As the introduction of new crops implies a long-term investment, public research should fill the gap in the early phases of research.

The development of new products of well-known plants takes shorter time. An example: First After 5 years of research to find a suitable cultivar, I got funding for a project in 1996 with the aim of starting a commercial production of raspberries for fresh market in Norway. Everybody joining in the project learned a lot the next 5 years, but nobody had a great economically success. However, since then the sale has doubled every year, and the growers are earning money. Raspberries for fresh market gives much better income for the growers and retailers than the traditional production for the jam industry.

Establishing a new product can be challenging for several reasons. Producers (growers and industry) and marketers must work together to develop the product, and not forget that the product should bring a reasonable return to the producers. Producers must determine consumer demands and develop methods of production that meet those demands. Consumer awareness and acceptance of a new product must be developed before markets can be established.

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Genetic Diversity in Recently Domesticated Fruit and Berry Crops

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Acquisition of a suitable plant material is a critical step in the domestication process. For some crops we still have to rely mainly on wild-collected material. For more advanced crops, cultivars may already have been developed but there is usually room for considerable improvement. The evaluation of genetic resources and their employment in modern plant breeding programs require efficient methods to estimate genetic diversity at different levels. Commonly used DNA-based methods (AFLP, ISSR, RAPD, SSR) will be reviewed here, exemplified with data for some fruit and berry crops grown in Northern Europe (see also Weising et al., 2005).

In general, estimations of diversity within wild-growing populations show strong associations with life history traits, especially mode of reproduction (Nybom, 2004). Comparatively high levels of within-population diversity have thus been recorded for lingonberry and intermediate levels for Japanese quince and the diploid populations of black chokeberry (Nybom et al., 2003). Sea buckthorn and the tetraploid populations of black chokeberry instead show low levels of polymorphism, presumably due to the early successional status of the former species and to apomixis (seed set without fertilization) in the latter species. Very low between-population differentiation has been found in three outcrossing species: lingonberry, Japanese quince and sea buckthorn. Considerably higher values have been noted for species with seriously restricted genetic recombination like dogroses (which have the aberrant *canina* meiosis) and for tetraploid black chokeberry populations (which are apomictic).

Discrimination of genotypes in gene banks and other genetic resource collections can usually be achieved with any of the DNA-based methods, with the exception of black chokeberry, where some cultivars appear to consist of the same, apomictically reproducing genotype. In dogroses, a special situation exists due to the *canina* meiosis, which results in matroclinal offspring, i.e. offspring that resemble their seed parent much more than their pollen parent.

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Japanese quince (*Chaenomeles japonica*) – a promising productive organic fruit crop

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Japanese quince, *Chaenomeles japonica* (Thunb.) Lindl., is a temperate Asian pome fruit with yellow peel, acid fruit flesh rich in aroma, antixoidants and dietary fibre. Despite being domesticated and cultivated as a minor fruit crop in the Baltic countries for more than forty years most of Japanese quince orchards are still established using plants which are propagated by seeds. This results in a large diversity in every character including important yield and quality traits and make field management difficult and cultivation less profitable. However, as a result of plant breeding efforts during the last fifteen years advanced selections are now available and grown in comparative field trials using organic management practices. The objective is to select superior clones to be introduced in the market. An overview of Japanese quince research will be presented with a special focus on recent results obtained from ongoing field trials. Preliminary results confirm that Japanese quince is a crop amenable to organic cultivation, with a large potential yield of high quality fruits which could be used for development of conventional and functional foods.

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Sea Buckthorn – cultivation and harvest method at Torslunda Research Station, Sweden

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In 1997 started a project, called ”Industrial crops on Öland” at Torslunda experimental station. This project introduced the cultivation of Sea Buckthorn in Sweden. The experimental field of Sea Buckthorn on Torslunda experimental station is 2500 m^2 and the aim is to test cultivation and harvesting methods of different cultivars. Sea Buckthorn is very difficult to harvest since the berries have none or very short stems and easily breaks when they are picked. The branches also have long sharp thorns which make the harvest difficult. Among the harvesting methods tested a method from Germany turned out to be the best. Whole branches with berries were cut and then immediately frozen to below –22C for twenty-four hours and subsequently threshered still frozen. This method of harvesting has proved successful and the berries come of easily. A trail-thresher originally designed for beans was used with good results. We have so far harvested the Sea Buckthorn with this method since 2002. Sea Buckthorn only carries fruit on the last years branches, so by using this method, the plants can only be harvested every second year. Although the plants only can be harvested every second year this method still is more effective and gives higher yields per plant than the other methods we have tested such as hand picking or shaking. The method is used in commercial production since three years by a local farmer with 1 ha Sea Buckthorn. We believe that today this method is the most effective way of harvesting Sea Buckthorn.

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Strawberries and raspberries in tunnels, experiences from Rånna Experimental Station, Sweden

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Production of strawberries and raspberries in tunnels is slowly increasing in Sweden. There are only approx. ten hectares of strawberries and a few hectares of raspberries in tunnels and the grower's attitude is cautious. The main interest is in the early production of strawberries and in raspberries. With tunnels, the production period can expand with approx. two weeks before and after the main season. The strawberry prices are commonly high before midsummer and often also in the end of summer. Most of the Swedish production of soft fruits is sold outside the supermarkets, from different market stalls or from farm shops. It is a matter of time until the supermarkets wants the strawberries back inside the stores. Then, we can expect an increased demand of high quality soft fruits grown under protection of tunnels.

There are many advantages with soft fruits in tunnels

- early production
- high quality fruits
- no problems with grey mould (*Botrytis cinerea)*
- high efficacy of beneficials in mite and aphid control.
- less use of chemicals

The main problems are

- high costs
- difficulties to get enough ventilation during hot periods
- powdery mildew
- tarsonemid mites
- aphids

During 2003-2005 a project with strawberries and raspberries in tunnels was conducted at SLU, Rånna Experimental Station, Skövde. The main goal of the experiment was to show the possibilities to produce high quality fruits during an elongated season with reduced use of chemicals. The study showed some of the differences between growing in tunnels and outdoors. In strawberries the total yield did not differ much between tunnels and outdoor but the cause of damage fruits differed. In tunnels the fruits were infected by powdery mildew due to the warm and dry climate and outdoors the fruits were damaged by rain. In raspberries, the yield of cv. Glen Ample was 82 per cent higher in tunnels and the harvest period started two weeks earlier compared to outdoors.

Important conclusions for tunnel production

- only strawberry cultivars with high resistance to powdery mildew
- early close of tunnels in spring, March
- increase the air humidity with sprinklers before flowering in strawberries
- early introduction of predatory mites
- early control of aphids in raspberries
- quick and effective ventilation as soon the temperature raise above 22°C

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Lingonberry *(Vaccinium vitis-idaea*) – the red gold of Sweden

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Lingonberry *(Vaccinium vitis-idaea*) is a small evergreen shrub with bright red, tart berries that are used for processing into e.g. lingonberry jam, juice, syrup, liqueur and yoghurt. Lingonberry products are especially popular in the Nordic countries (in Sweden lingonberries are known as the 'red gold'), but they have become more accessible also in several other countries. Quality and yield of native stands are affected by genetic differences as well as by e.g. weather fluctuations. In addition, modified forest management and urban encroachment decreased the biomass of lingonberry plants during the 20th century, with negative effects on berry production.

Since the 1960s, investigations with the aim to domesticate lingonberry have been conducted in Sweden, Finland, Germany, Poland, Netherlands, Belarus, Russia and USA. Initial experiments suggest that yield can be increased up to five times when lingonberries are grown under controlled conditions. Lingonberry cultivars are still developed mainly by selection of outstanding genotypes from wild stands. In this manner, 'Sussi', 'Sanna', 'Ida' and 'Linnea' were selected and named at Balsgård. Propagation experiments, using stem cuttings and micropropagation, have been undertaken in Sweden, Lithuania, Canada and USA. Studies on cultivation conditions and weed control have been carried out mainly in Sweden, Finland and USA.

At Balsgård, genetic diversity in wild-growing populations has been studied using morphological and physiological traits as well as molecular markers. In one project, RAPD markers were used in combination with an automated image analysis of leaf shape to evaluate the clonal structure of lingonberry populations. In another project, 15 populations were evaluated for 17 horticulturally important traits such as plant growth, disease susceptibility, etc. Eight of these populations and seven additional populations were included in a RAPD-based study on genetic diversity. The results were used to create a lingonberry gene bank at Balsgård. Unfortunately, limited resources have now brought about a temporary interruption of the lingonberry program at Balsgård. At present, the most important task is to preserve our gene bank for future chemical screening and applied plant breeding.

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