GenRes Carrot Newsletter No. 4

January 2004

CEC Contract no. GENRES-CT99-105

Project News and Information

"THE END"

Well after 4 very successful years the GENRES Carrot project ended on New Year's Eve 2003. As the Co-ordinator of the project I would just like to record my thanks to all the participants in the partner teams for their work inputs and for making the project such an enjoyable experience.

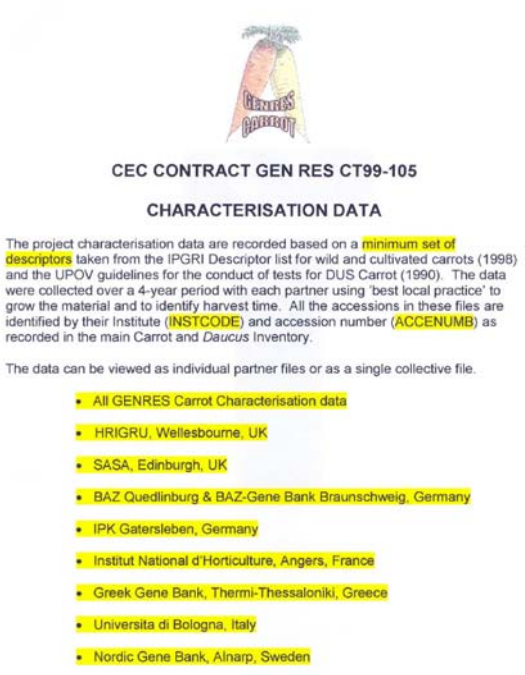
"Or is it the beginning of something new?"

The group held a very successful final meeting in Quedlinburg hosted Thomas Nothnagel at the BAZ. We enjoyed a visit to the institute to view the work relating to umbellifer crops, particularly: image analysis especially interesting for carrot leaves (Dr. R. Ahne), aroma analysis of carrots (Dr. D. Ulrich), NIR analysis of the carotene and sugar content of carrots (Dr. R. Quilitsch), *in-vitro* culture, protoplast fusion of umbellifers (Dr. U. Ryschka), molecular markers in carrots and celleriac (Dr.E.Klocke). We followed the lab tour with a visit to see Thomas'experimental material in the glasshouse.

News from HRI Genetic Resources Unit

One of the main inputs by HRIGRU this year has been the co-ordination of the project characterisation data and their presentation on the project web pages. Partners supplied HRIGRU with data sets that were checked for compliance with the agreed format and then saved as read-only Excel files. The partner data files and a full GENRES Carrot characterisation data set (read-only) have been linked to the Internet project web pages in association with the ECDI providing public access to these data. The web page shown below is now active providing direct access to the project data.

The GENRES Carrot project web site will remain active to provide access to the European Carrot Inventory and the various data produced by the partners.
www.hri.ac.uk/gru/gen_res/genres.htm



CEC CONTRACT GEN RES CT99-105

CHARACTERISATION DATA

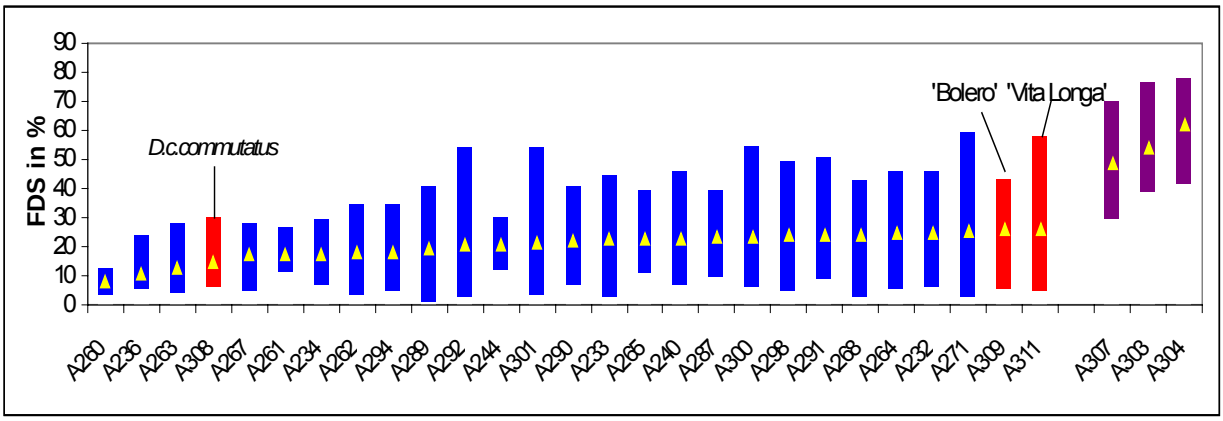
The project characterisation data are recorded based on a minimum set of descriptors taken from the IPGRI Descriptor list for wild and cultivated carrots (1998) and the UPOV guidelines for the conduct of tests for DUS Carrot (1990). The data were collected over a 4-year period with each partner using 'best local practice' to grow the material and to identify harvest time. All the accessions in these files are identified by their Institute (INSTCODE) and accession number (ACCENUMB) as recorded in the main Carrot and *Daucus* Inventory.

The data can be viewed as individual partner files or as a single collective file.

- All GENRES Carrot Characterisation data
- HRIGRU, Wellesbourne, UK
- SASA, Edinburgh, UK
- BAZ Quedlinburg & BAZ-Gene Bank Braunschweig, Germany
- IPK Gatersleben, Germany
- Institut National d'Horticulture, Angers, France
- Greek Gene Bank, Thermi-Thessaloniki, Greece
- Universita di Bologna, Italy
- Nordic Gene Bank, Alnarp, Sweden

Federal Centre for Breeding Research on Cultivated Plants (BAfZ), Quedlinburg News
The 2003 *Alternaria* screening programme comprised the repeat testing of the best 30 accessions from 2001 and 2002. In addition, 5 accessions from Mathilde Briard in Angers and the standards were tested in a parallel laboratory test and semi-field test similar to the evaluation in 2001 and 2002. In a separate experiment a collection of 22 wild forms from the Greek Gene Bank plus standards were evaluated in two laboratory tests. Between January and May 2003 the 2 inoculum (I89001 & I189 - see newsletters Nos.2 & 3) were propagated under *in vitro* conditions.

Laboratory test
A significant variation was observed for the resistance expression between the four test replications, but the rank order of the individual accessions was more or less stable. Twenty-five accessions were selected as more resistant than 'Bolero' (Fig.1). These may be interesting for resistance breeding. A number of plants were selected without disease symptoms during the tests. Seed production on these plants is in progress.



More or less all accessions of the Greek Gene Bank, preliminary classified as *D.carota carota* and *D.muricatus,* were scored as being more 'susceptible' against *Alternaria dauci* than the Standards 'Bolero' and 'Presto'.

Semi-field test
The environmental conditions during the disease incubation time were rather extreme in 2003 with the temperature rising sometimes to more than 50°C. Combined with the high humidity (irrigation) this led to a very high disease pressure. As a result 19 accessions died before the evaluation. Generally, the *Alternaria* symptoms in the field test were heavier than in the laboratory tests and, in addition, the many field accessions suffered from secondary infections of *Erwinia* root rot and other pathogens. Therefore only a partial evaluation was possible and symptom-free plants indicating 'resistance' could not be identified. Only 10 accessions were classified as 'tolerant' or 'moderately tolerant', and 70 accessions as 'susceptible'.

News from the Federal Centre for Breeding Research on Cultivated Plants - Gene Bank, Braunschweig
The BAZ Gene Bank produced seeds of 7 accessions in 2003. In addition to the project work plan fifteen plant traits were scored, counted or measured to characterise 11 accessions (6 wild types, 1 new variety, 4 accessions from the genebank holding) along with the 3 standard varieties. Therewith the gene bank finished the work on carrot.

News from the Scottish Agricultural Science Agency, Edinburgh
Images from GENRES trials
In 2003, data for the 2002 trial were analysed and presented to the project partners for inclusion on the project web site. In addition to the trial data, images were captured from characterisation trials:

2000: 77 accessions, representing a wide range of traditional cross-pollinated cultivars were photographed and the images stored in digital (jpeg) format:

- External view of 4 whole roots representing each root type in the population
- Internal view of 4 roots in longitudinal section representing each root type in the population

Each Image is labelled with Year, GBRSASA Accession Number & Plot number.

These images are now available on CD to project partners.

2001: 50 landrace populations and 30 traditional cross-pollinated cultivars were photographed and stored in digital (jpeg) format:

- Plot view of foliage
- 5 leaves representing the population
- 5 leaflets
- 5 sub-leaflets
- External view of 4 whole roots representing each root type in the population
- Internal view of 4 roots in longitudinal section representing each root type in the population.

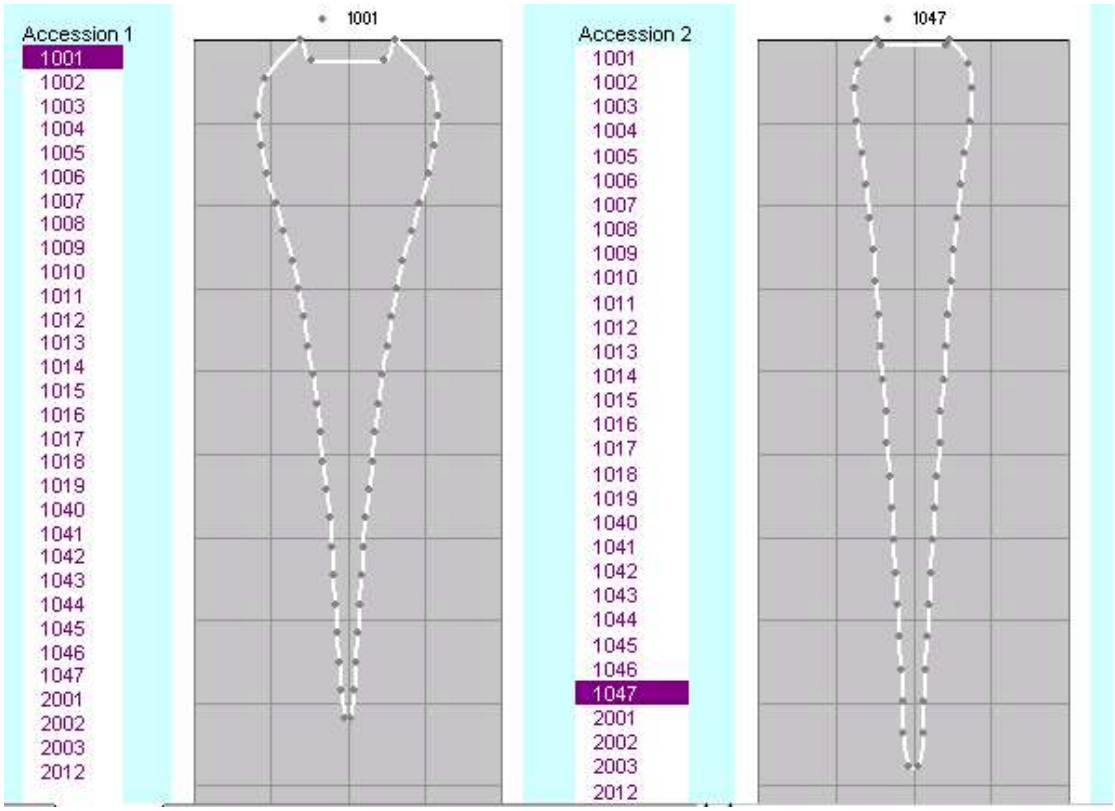
Each Image is labelled with Year, GBRSASA Accession Number & Plot number.

Umbellifer news: Parsnip

Characterisation of heritage material and commercial cultivars continued at SASA in 2003. The UK reference collection, used for Distinctness, Uniformity and Stability tests for granting European Plant Breeders' Rights, now contains 47 different cultivars.

A new UPOV guideline has been drafted and awaits publication. The guideline gives information on characters and character states used for describing cultivars, and lists example cultivars for most of the character states.

Development work continues on the automatic measurement of Parsnip roots (see Carrot Newsletter No. 3), which can also be applied to Carrots. A new tool has been developed by Graham Horgan of Biomathematics and Statistics Scotland, which allows the comparison of the average shape of any two populations. Measurements of individual roots are obtained from a purpose-built software program, with the averaging, display and comparison of average outlines being performed in Microsoft Excel.



News - Institut für Pflanzengenetik und Kulturpflanzenforschung, Gatersleben

The Gatersleben genebank is one department of the 'Institut für Pflanzengenetik und Kulturpflanzenforschung' (IPK) which was founded in 1943. Central for the genebank are collection, conservation, characterisation, evaluation and documentation of plant genetic resources to cover a wide range of demands in plant breeding and science. More than 140 collecting missions to regions of diversity world-wide were conducted in the past decades. As a result it was possible to integrate many often irreplaceable original accessions into the collection stocks of this genebank. The number of accessions has grown continuously up to about 100,000 in the year 2002 covering a wide range of 2,500 taxa belonging to 689 genera and 87 families.

Due to the political division of Germany after the world war two in 1945 and the fact that Gatersleben was located in the former eastern part of Germany (GDR) a separate genebank was created in Braunschweig (W. Germany) in the early Seventies of the last century. There a collection up to 50,000 accessions was created.
After the political re-unification of Germany in 1990 efforts were initiated to build up a 'Central German *ex situ* Genebank'. During 2002/2003 the complete Braunschweig collection was transferred to Gatersleben, where now about 150,000 accessions are maintained, comprising cereals and grasses (70,000 accessions), legumes (30,000 accessions), vegetables (20,000 accessions), potatoes (6,000 accessions), oil seeds and fibre plants (10,000 accessions), medicinal herbs (6,000 accessions) and others (5,000 accessions).

The genus *Daucus*, a rather small group, consist of 505 accessions belonging to 6 different species and 11 subspecies (Table 1). The passport data of the material, i.e. information concerning the identity, history, geographical origin or botanical determination can be searched via Internet (http://www.ipk-gatersleben.de).

Table 1: *Daucus* collection - German *ex situ* Genebank in IPK Gatersleben

Species/Subspecies	Accession numbers		
	IPK	BAZ	Total
Daucus carota L.	0	59	59
Daucus carota L.*ssp.carota*	17	20	37
Daucus carota L.*ssp.commutatus* (Paol.)Thell.	5	0	5
Daucus carota L.*ssp.gadecei* (Roy et Camus) Heyw.	1	0	1
Daucus carota L.*ssp.gummifer* Hook.f.	4	0	4
Daucus carota L.*ssp.hispanicus* (Goyan)Thell.	2	0	2
Daucus carota L.*ssp.hispidus* (Arcang.)Heyw.	1	0	1
Daucus carota L.*ssp.major* (Vis.)Arcang.	3	0	3
Daucus carota L.*ssp.maritimus* (Lam.)Batt.	2	0	2
Daucus carota L.*ssp.maximus* (Desf.)Ball.	15	1	16
Daucus carota L.*ssp.sativus* (Hoffm.)Arcang.et Mart.	220	87	307
Daucus aureus Desf.	1	0	1
Daucus broteri Ten.	3	0	3
Daucus guttatus Sibth.et Swz.	3	0	3
Daucus guttatus Sibth.et Swz.*ssp.zahariadii* Heyw.	2	0	2
Daucus halophilus Brot.	1	0	1
Daucus muricatus L.	3	0	3
Daucus sp.	55	0	55
Total	**338**	**167**	**505**

News from Institut National d'Horticulture, Angers

Molecular characterisation: Jaune du Doubs trial

Our manuscript has been accepted for publication by the Editor, Prof. A.T. Bull from Kluwer and will appear in one of the next issues of the journal: Biodiversity and Conservation. The title of the paper is "Identification of duplicates for the optimization of carrot collection management" with the following Key words: AFLP, bulked DNA, genetic resources, rationalisation, redundant accessions.

Molecular characterisation: analysis of heterogeneous accessions

Most of the carrot accessions maintained in genebanks are open pollinated populations exhibiting some degree of heterogeneity. Some accessions appear to be very heterogeneous showing a range of root colours, such as yellow, orange, white and purple. In such cases, we were interested to investigate the best way to conserve such accessions in the collection. If the "population" represents a bulk of different accessions, it will probably be better to separate the different root types in order to simplify their conservation. In this case, the different root colour types should be genetically different. In contrast, if the heterogeneity is only visual and probably due to one punctual mutation, the root types will be genetically identical except for one character. In this second case, the root types would have to be conserved as a single accession.

In order to test the two hypotheses, we carried out a study on 7 accessions, each represented by 2 to 4 different root colour types (orange, yellow, white, purple or intermediate).

Alternaria dauci trial 2003

The trial was performed as previously described (see Genres Newsletters 1, 2 and 3). Of the 34 accessions and 4 controls scored, 12 were previously tested for *Alternaria* resistance in Quedlinburg or Angers, and 22 had been scored by partners for other diseases. The cultivars Bolero and Presto were used as positive and negative controls. An American line (5280) and Brasilia are also known to be as partially resistant as Boléro. The material was sown on 12th of June, inoculated on the 7 and 16th of July 2003 and. Scored on the 11th and 25th of August. The weather conditions were favourable for the development of the fungus, and thus symptoms. The range among accessions varied from 2.5 to 5.1 at the second scoring date. Presto, the susceptible control was hardly attacked. Attacks were less significant than in the trial of 2002.

Other news

On the 11th March 2003, a new carrot breeder, Pierre Cicerello-Briard, joined us. As shown on figure 1, he is already characterising FRAINH accessions!

News from the Greek Gene Bank

The project group discussed the options for the collection of germplasm within the project. The island of Crete was proposed because of the richness of the flora and the fact that no carrot/*Daucus* is represented in genetic resources collections. The exploration of the island of Crete was carried out in August 2003 a collecting team of the Greek Gene Bank in collaboration with the Horticulture Research International, UK (HRI). The principal goals were:

- to collect and rescue the endangered genetic resources of carrot & *Daucus* species
- to estimate the degree of genetic erosion.
- to identify areas with high genetic diversity.

A total of 60 samples of *Daucus* were collected. Only one local variety could be found being grown organically, even this has been reintroduced having not been grown widely on the island for 30 years. We collected wild taxa including, 28 *D.carota ssp carota*, 18 *D.muricatus*, 6 *D.pumilus*, 6 *D.involucratus*, 1 *D.guttatus* and 6 *Daucus* sp. Although *D.bicolor* appears in the literature as present in Crete, no material was found. We named some of our collections as *D.muricatus?*, but since we can find no reference to this taxon in the literature on the Cretan flora. *D.muricatus* is found in several locations and at different altitudes in Mediterranean countries from sea level up to 1,200 m. We will grow and study our material in order to validate the taxonomic identity.

It was extremely difficult to locate the "straw-coloured" stems and spiny seeds of *Daucus* taxa in a sea of "straw-coloured" vegetation, much of which has spiny seeds. Some of the smaller taxa were well hidden under spiny bushes and in the crevices between rocks. We only found one scorpion, it was not in the wild, but given to us by 2 little old ladies – a story too long to recount here!!

News from the Department of Agro-environmetal Science and Technology, Bologna

2003: a year of thought and balances….

The characterisation and evaluation were fulfilled well in advance, during the previous three years. The only 15 accessions left to evaluate made life easy and allowed a bit going back with the mind, at the past four years, but also looking forward, posing ourselves some questions on the basis of the work done.

We will start and end with a balance: first a general overview, also including "sentimental" notes, and finally a technical summary of project outputs. In the middle will stay our 2003 activity, made of some research that indeed opened more questions than it solved! At the very end, a wish for the future.

Overview

Indeed these have been four exciting years. The evaluation of germplasm was so far from our usual experimental activity: no preliminary hypothesis, no experiment to test it; only anonymous carrot accessions to characterise and evaluate. A service to the community, maybe?

But, luckily, carrot is nice to see. And seeing it made the work easier. We frequently thought about colleagues working with beets, wondering if they had much more solid scientific motivation! Wonderful variability in shape and colour came out; and this beauty was caught in photographs, to be enclosed to the purely numerical characterisation and evaluation. For sure, we liked diversity, but it was a bit disappointed to find sometimes too much of it within accessions! This indeed did not make life easy for characterisation and, even more, for evaluation. We could not split heterogeneous accessions, so average analytical data may not be best the best option.
We were not acquainted with such different shapes. But then we realised that many scientists studied shape and tried to convert it into numbers. Also our descriptor 7.4.14 did it. But something was not yet satisfactory. So we worked on shape too, doing some extra measurements of individual root length, diameter and weight. And we hope to be soon ready to come out with our data processed, and discuss about root shape again.
OK, germplasm evaluation was not the same thing as usual field experiments. But something similar happened. In summer 2002 we succeeded to have our sandy soil plots waterlogged. Our roots suffered, so we sowed again. We therefore had two harvests, summer and fall. And this gave rise to our "brain storming?" question about the genotype x environment interaction (see later).
Then, it finally happened that we fell into temptation, and felt the desire to taste what we appreciated with our eyes. And this gave rise to our second final year's question (see also later).
Last but not least, was the group. The latitudinal range was great, so were characters. But everybody was well motivated and with positive aptitudes. This made pleasant working together and leaves now with some hope of going on.

The Group

Miss Roberta Neri had the responsibility of the whole field and sample management. She did most of the characterisation work and organised the last year's sensory evaluation. She kept everything in order for everybody.

Miss Simona Elementi had the responsibility of the lab work and did a lot of analyses. She effectively managed also the students' work and acted as a constant reference.

Miss Manuela Drei seriously and quietly worked during two years, first for her thesis, then with as temporary researcher

Mr. Zivojin Rakic, from Yugoslavia entered for a PhD in 2001, working on several topics, partially supported by the carrot program, and getting through the consular bureaucracy for visas and permits of stay.

L. Filippo D'Antuono was officially the project leader, and officially had the responsibility for what went wrong, leaving the successes to be reported by the others.

Year 2003 questions

1) Can evaluation bring out something beautiful, tasteful and of commercial interest?

Commercial and production structure pushes towards standardisation, increasing size and, in one word, uniformity. It is said that people (consumers) seek for differentiation. The same is said for small size growers. Our working group was small; we liked diversity and were fascinated by some peculiar carrot shape and colours; taste of some of them was also nice. We thought that it could add pleasure to our meals. But were we representative? Could some unconventional carrot type meet "consumers' " likes?
We chose 19 accessions for several characters: 6 were commercial varieties, the remaining gene bank accessions: Bolero, Parmex, Amsterdam, Autumn king, News F1, Rubrovitamina and the following other 15 accessions, distinguished in the previous years by various characters: HRI 3937, high carotenes, high terpinolene essential oil; HRI 4007, sweet; HRI 6102, nice shape and colour, high sugars and carotenes; HRI 6760, nice, pink salmon external colour; HRI 6519, yellow, high bisabolene essential oil; HRI 7801, high sugars and carotenes; NGB 2399, nice: orange external, yellow internal colour; high sugar, average carotenes; INH 1 high content of minor essential oil components; INH 14 Parijse Markt: unusual shape for Italy; BAZ 69563 Rubica high sugars; BAZ 56367, Scarlet nantes stump root, dark orange, high bisabolene in essential oil; BAZ 62633, Konfrix, high carotenes.

We planned sensory evaluation sessions (table 1). Consumers buy by eye, first of all. So we asked panellist to indicate their appreciation of visual characters such as shape, external and internal colour, besides overall visual acceptance. Then, remembering the nice crisp texture and mild taste of a purple/yellow type, we also planned tasting sessions in which panellist were asked to rank intensity of sweet, aromatic, crisp, tough and fibrous perceptions, and then express overall acceptance. A 100mm non-structured scale with only two extreme anchor words was used.

Table 1. Results of sensory evaluation of selected carrot accessions

	external sensory evaluation (acceptance)				sensory evaluation (tasting)					
			colour		Global	character intensity				
accession	global	shape	external	internal	Acceptance	crisp	tough	fibrous	aroma	sweet
HRI 6102	81.4	80.0	80.8	87.1	54.4	72.1	67.4	57.9	63.7	42.4
INH 1 - Tilques	78.8	79.4	81.9	78.8	67.1	81.4	73.3	53.8	66.5	54.6
Rubrovitamina	78.6	81.4	77.9	76.5	60.8	79.6	69.8	49.9	67.2	56.4
News f1	77.6	75.6	78.1	79.7	62.9	78.0	69.4	44.4	46.2	52.5
Bolero	76.8	71.3	75.0	77.3	72.0	82.5	72.1	42.5	57.5	61.8
HRI7801	76.7	70.1	80.5	78.0	67.8	73.1	70.4	44.9	61.9	60.5
Autumn King	75.6	72.0	72.1	79.0	56.9	76.2	67.3	49.8	59.5	43.0
Amsterdam	70.1	69.4	64.1	71.4	64.4	71.7	70.2	45.7	59.8	55.7
HRI3838	63.5	51.6	67.0	68.3	61.8	70.6	63.4	46.3	58.6	51.2
INH 14 - Parijs markt	62.7	52.9	65.9	69.7	56.5	67.7	67.8	55.6	57.3	53.3
BAZ352	54.4	46.2	61.4	62.3	-------	-------	-------	-------	-------	-------
HRI3937	52.6	58.5	53.2	44.7	62.0	71.3	63.2	43.7	59.1	58.3
HRI6760	52.1	65.5	48.8	43.7	52.7	67.7	66.2	52.1	64.0	40.4
BAZ378	47.5	55.0	51.2	38.9	-------	-------	-------	-------	-------	-------
HRI4007	46.5	75.7	62.4	27.3	52.2	73.3	66.1	56.5	60.4	50.7
BAZ428	43.3	36.7	51.5	56.0	-------	-------	-------	-------	-------	-------
HRI6519	43.1	73.4	34.8	32.3	36.0	60.0	59.2	56.8	43.7	31.7
HRI13404	41.6	58.0	47.5	29.5	-------	-------	-------	-------	-------	-------
NGB2399	40.5	34.2	52.9	36.9	46.8	66.7	65.4	51.9	52.7	44.0
Parmex	37.4	35.2	40.4	44.7	53.7	70.8	68.0	49.6	56.3	45.1

HRI 6102, rating first for overall visual acceptance, was a "moderately non conventional" type indeed (see figure), with its long, conical shaped roots. It was however slender and deep orange. Almost all long conical rooted types ranked at the top positions. Some other slightly conical roots were well evaluated (e.g. Rubrovitamina). Most short conical rooted types were not highly appreciated. Our beloved purple HRI 6760 ranked only 13th, and all non-typical orange types did even worst. Commercial Bolero ranked first for tasting quality. Some germplasm accessions were well evaluated for specific characters; some of them lacked sweetness.

As a whole, our enthusiasm for diversity was somewhat frustrated. Maybe our panel made of students and University personnel did not represent the whole population; but almost certainly they were not less open-minded that whole population. Or may also be that panellist expected to evaluate typical carrots, not expecting strange shapes and colours. Anyway, peculiar types with good tasting quality do exist. Some of them may try the adventure of exiting long term storage, for a breeze of open air. But they should not expect to find people willing to invest a lot of money for them. Until now they seem suitable for niche markets, from where they could increase, maybe, their popularity, with self-promotion.

2) Does the genotype x environment interaction affect the effectiveness of non replicated germplasm evaluation?

Despite our new task of germplasm evaluation, reminds of our classical agronomic studies came out, telling about the need of repeating the same things in several environment for several years.

We had some accession repeated indeed. And we decided to use some of them for a preliminary estimation of the genotype x environment interaction. We used total carotenes and nitrates as case-study characters, and two different situations: a) the 2001 and 2003 cycles, respectively with summer and fall harvests; and b) the 2002 cycle on both summer and fall harvests.

The results are reported in figures 2a-2d. The accession x interaction was significant in all cases. Even for the 2002 carotenes, for which no significant "harvest time" effect was detected, the genotypes responded differently to the environment. This means, for example, that some accessions kept low nitrates in both summer and fall (e.g. Amsterdam), while other increased them a lot (INH 1): that's interesting, but what about accessions not tested in both seasons and how to rank accessions? Also for carotenes, some accessions had higher amounts in summer, others in the autumn. Control varieties were always present, but they were also subject to the genotype x environment interaction. So, a lot of work was done, and made us getting to know previously unexplored germplasm. But how can our data lead to generalised output? We will go back again to this question and try to give better answer.

Food technology graduation theses

2002: Miss Manuela Drei, mark 110/110

2003: Miss Anna Zini, mark 100/110 cum laude

Forthcoming

2004: Mr. Filippo Sarti (forecast March, 2004), Miss Linda Mazzotti (forecast July, 2004)

PhD theses

Zivojin Rakic, forecasted 2005 (see next paragraph)

Grants and training

Miss Manuela Drei had half of her one year Bologna University post-graduate grant paid on the contract; she worked on the analytical part of evaluation, acquiring good skill in lab techniques.

Mr. Zivojin Rakic had one year of his PhD supported by the carrot program; he was rather eclectic, helping in both field and lab determinations. Enough material for his PhD thesis was collected.

Contributions at meetings

2002: 6th scientific meeting of the Italian Horticultural Science; citation: Moretti A., Neri R., D'Antuono L. F., 2002. Valutazione di pigmenti, zuccheri ed acidi organici in germoplasma di carota. In: Pandolfi S., Parlati M.V., Libori F. (eds.), Atti VI giornate scientifiche SOI, 22-25 Aprile 2002, Spoleto., 443-444.

Forthcoming

2004: 7th scientific meeting of the Italian Horticultural Science, Naples, 4-6 May 2004:- L.Filippo D'Antuono, Simona Elementi, Roberta Neri, Zivojin Rakic. Problematiche della interazione tra genotipo ed ambiente nella valutazione di collezioni di germoplasma: un esempio su caratteri qualitativi ed analitici di carota.

2004: ISHS: 5th international post-harvest symposium, Verona, 6-11 June 2004:- L. Filippo D'Antuono, Roberta Neri, Simona Elementi. Screening a carrot germplasm collection for potential new types by means of sensory analysis and analytical determinations

A wish for the future

European research programmes are difficult to win, and perhaps the idea of Europe is facing not the best period. But where else can we find such a naturally multi-ethnic place with most people still having their roots? The announcement of a new GENRES programme gives us the hope of having the opportunity to work together again as a project group.

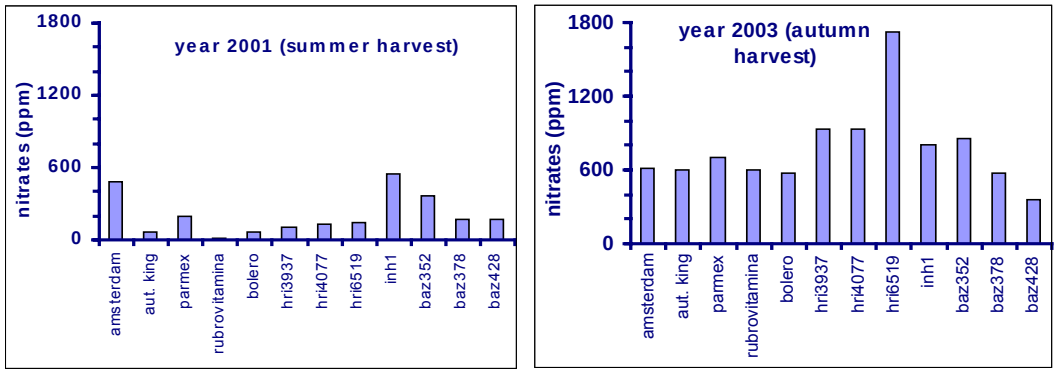


Figure 2a. Nitrate content in some selected accessions in the years 2001 and 2003. Effects: accession **; year **; accession x year **

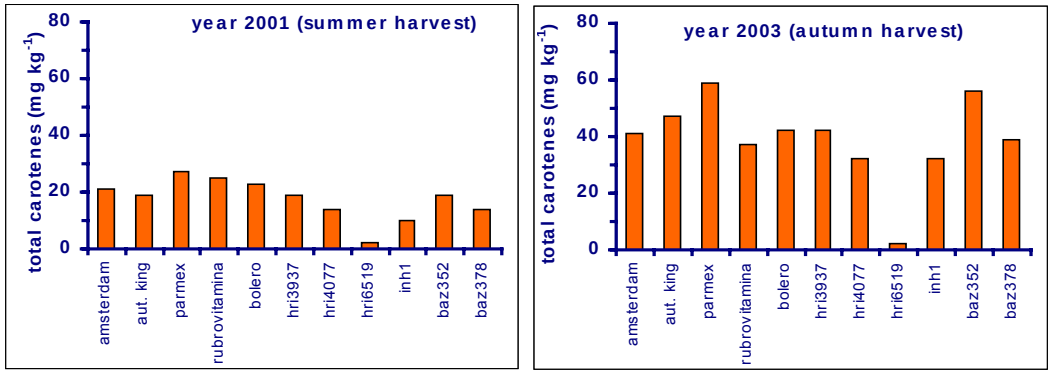


Figure 2b. Total carotene content some selected accessions in the years 2001 and 2003. Effects: accession **; year n.s.; accession x year **

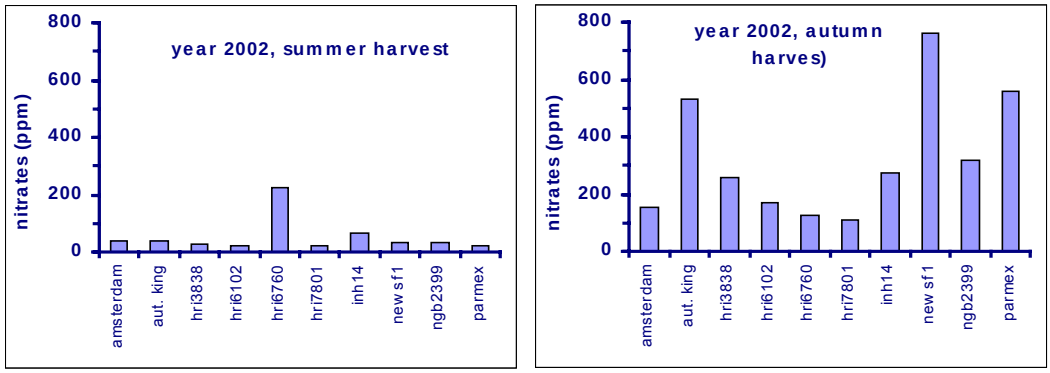


Figure 2c. Nitrate content in some selected accessions in summer and fall harvest, year 2002. Effects: accession **; season **; accession x season **

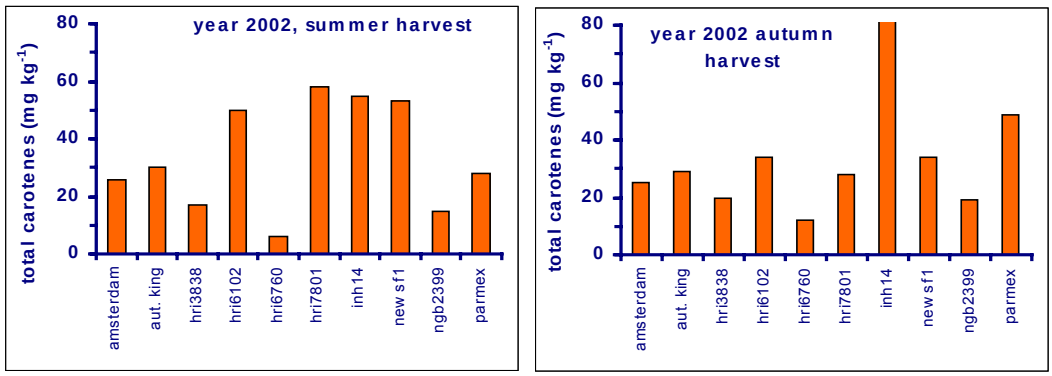


Figure 2d. Total carotene content in some selected accessions in summer and fall harvest, year 2002. Effects: accession **; season **; accession x season **

News from the Nordic Gene Bank

Last summer the weather in Sweden was hot and dry. The carrots were harvested in the end of October at the time when we had a very cold period with temperatures below zero.

All accessions of *Daucus carota* ssp. *sativus* stored at the Nordic Gene Bank have been characterised for their morphological characters. The characterisation work was finished during 2003. Digital photographs were taken on the carrots at harvest. The photograph to the right shows the variation of colour in the W:S Gelbe Futtermohre.

In the project, the Nordic accessions have been tested for resistance to Sclerotina soft rot (*Sclerotinia sclerotiorum*), Crater rot (*Rhizoctonia carotae*) and Liquorice rot (*Mycocentrospora acerina*). Quality characters, such as the content of carotenoids, sugars and nitrate, have been analyzed.

Table 1. Results from storage tests 2002 showing the five best NGB accessions in the tests.

Crater rot	Liquorice rot	Sclerotina soft rot	Total
NGB 13981	NGB 13980	NGB 13943	NGB 13980
NGB 13951	NGB 7745	NGB 13949	NGB 13981
NGB 13969	NGB 13162	NGB 13942	NGB 13979
NGB 547	NGB 11868	NGB 13969	NGB 547
NGB 13946	NGB 7748	NGB 11862	NGB 2399

During the fourth year, the tests for resistance to storage rots and the analyses of harvest and nutritional quality were repeated for the Nordic accessions that had shown good results in evaluations in the previous years. Five accessions from HRI and INH, which had shown resistance to *Alternaria*, leaf blight and cavity spot were also evaluated with respect to quality characters and resistance to storage diseases. The table below shows the five best accessions from the storage tests in 2002, as well as the five best accessions from the three storage tests summed together. The results from the tests in 2003 will be shown in the final report.

News from the Research Institute of Vegetable Crops, Skierniewice, Poland

The working collection of carrot (*Daucus carota* L.) is located at Krzeszowice near Krakow.

Seed production in 2002 included 15 carrot local cultivars from Japan, Lithuania, Russia and Poland, and in 2003 accessions (20) were grown from China, France, The Netherlands, Uzbekistan, Japan, Great Britain, Russia, Ukraine and Poland. We harvested sufficient seeds for conservation of 11 accessions in 2002 and 20 accessions in 2003.

Characterisation

In the 2002 field trials we evaluated 20 carrot accessions from China, France, The Netherlands, Uzbekistan, Japan, Great Britain, Russia, Ukraine and Poland, and in 2003 evaluated 24 accessions from Uzbekistan, Russia and Poland. Seeds were sown in 20m plots the field in late May in 2 replications with the roots being harvested in early October. In both years carrot accessions were scored for 43 morphological and agronomic traits, and 6 biochemical compounds based on UPOV and IPGRI carrot descriptors (IPGRI. 1998) including traits such as leaf length, root length, root and core diameter, root weight, colour, yield and its structure, and also storage ability. The biochemical characterisation of roots included: dry matter, monosaccharides and total sugar content, carotene and nitrate. During the vegetative period, germination, plant vigour, leaf characterisation and reaction to pathogens were recorded with observations made on random samples of leaves or roots. The data reported are average results of observations made on 30-50 plants randomly

selected from each accession. Photographic documentation was made for leaves and roots of characterised carrot accessions. The results showed great variability in the traits within and between the individual local and old cultivars of carrot. The characterisation and evaluation data of carrot germplasm indicates a rich source of genetic variability and makes the material deposited in gene bank collections more useful for users.

Results showed variation in a number of characters
Average root weight ranged from 117g (Mirzoe Yellow 137) to 380g (Autumn King UKR 81) with 11 of the accessions with average root weights more than 200g.
Root length ranged from 7.5 cm (Parmex) to 21.5 cm (Autumn King).
Marketable yield ranged from 29% to 81% of the total yield.
The highest % of forked roots were in accessions 85-B (38%) & Nord (34%), & lowest % in Parmex (9%), POLAUG (10%) & Jawa (12%).
The majority of roots were orange, but 2 accessions had yellow roots (Mirzoj Yellow 137 & Yellow carrot 176), 2 with light orange (Duwicka & 85-B) and 1 dark orange.
Significant differences were observed in sugar content with total sugars ranging from 5.3% (Yellow carrot) to 8.5% (Amager and NIOCH-336), and reducing sugars from 2.1% (Autumn King) to 4.0% (Nord). In 5 accessions total sugar content was >8 %.
Carotene content (mg % of fresh matter) ranged from 2. 1mg % (Mirzoj Yellow 137) to 22.4mg % (NIIOCH-336), 23.1mg % (Selecta) and 24.0mg % (Autumn King). Carotene content in 6 accessions was more than 20mg %.
The ability of roots to accumulate nitrates varied significantly with the amount of nitrate in roots ranging from 87mg KNO_3/kg fresh matter (Autumn King) and 92mg KNO_3/kg (Duwicka) to 604mg KNO_3/kg (85-B) & 720mg KNO_3/kg (Amsterdamska). Of the 20 accessions analysed 6 had nitrate content <200mg, 5 had 200–300mg & 8 accessions had >300mg.
High variability was observed in the form, size and shape of leaves.

At the Agricultural University in Krakow genetic diversity of 27 accessions of *Daucus, Caucalis, Orlaya* and *Torilis* were evaluated on the basis of 144 markers, of which 67 were obtained using RAPD, and 77 using AFLP techniques. Genetic distance matrices were similar regardless of the type of marker used. Comparison of similarity matrices for seven accessions evaluated in all three years showed that the results were highly reproducible, which was confirmed by a similar tree topology. The results have been used by the curator as a tool for a more rational management of the collection.

Publications in Poland relating to carrot over the last 2 years:

Grzebelius D., Barański R., Kotlińska T., Michalik B., 2002a. Genetic diversity in the polish germplasm collection of carrot (*Daucus carota* L.). In Broad Variation and Precise Characterization – Limitation for the Future. Eds. Wojciech Święcicki, Barbara Naganowska, Bogdan Wolko. Eucarpia Section Genetic Resources- Wydaw-Drukarnia Prodruk: 183 – 185.

Grzebelus D., Baranski R., Żukowska E., Zabagło A., Kotlińska T., Michalik B. 2002b. Assessment of genetic diversity in a carrot (*Daucus carota* L.) germplasm collection. Plant Genetic Resources Newsletter, No. 130: 51 – 53.

Kotlińska T., Zabagło A., Żukowska E., 2002. Characterisation of morphological and economic traits of carrot germplasm. In. Broad Variation and Precise Characterization – Limitation for the Future. Eds. Wojciech Święcicki, Barbara Naganowska, Bogdan Wolko. Eucarpia Section Genetic Resources - Wydaw.- Drukarnia Prodruk: 218 – 220.

Barański R., Grzebelus D., Kotlińska T., Michalik B., 2003. Wykorzystanie markerów dna do oszacowania zmienności w polskiej kolekcji zasobów genowych marchwi (Use of DNA markers for evaluation of genetic diversity in the polish germplasm collection of carrot). Proc. of II Ogólnopolska Konferencja „Zasoby genowe roślin w ochronie różnorodności biologicznej (Plant genetic resources in biodiversity), Instytut Warzywnictwa, Skierniewice, Poland, October 21-23, 2003: 88 (in Polish).

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