

## ***Approaches and achievements of biodynamic vegetable breeding by Kultursaat e.V. (Germany) using the example of RODELIKA, one of the first certified biodynamic varieties***

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### **SPEAKERS BIO**

MSc Michael Fleck has been secretary of the non-profit association Kultursaat e.V. since 2006 and board member of ABDP since 2009. Before this he worked as a junior scientist at the University of Kassel (Witzenhausen). His focuses have been the quality of organic grown carrots and questions of plant breeding.

### **KEY WORDS**

breeding methods, property rights, quality traits

### **PAPER**

#### **Abstract**

Since 1998 RODELIKA is officially registered as a newly bred carrot variety. It had been developed by positive mass-selection over a 13 year period, based on an old-established variety within a farm based biodynamic system. The goal was a fine root with good health and a focus on taste and ability of maturation. Thus a selection-scheme in organoleptic characteristics sweetness and aroma was created. Numerous investigations demonstrate the very high inner quality of RODELIKA. Property rights of this open-pollinated variety are held by the charitable association Kultursaat eV as a common heritage.

#### **Background**

In the beginnings of organised (and certified) organic farming the use of ecologically propagated seeds was no subject. The biggest challenges in cropping were the realisation of adequate fertilisation regimes and techniques to control weeds, pests and diseases. The agricultural practitioners often had great trouble to obtain seeds – although conventionally bred and propagated – that were not chemically treated. Irrespective of some voices from the academic context that most of the modern varieties also seem to fit low-input-conditions (Büchting et al. 1986), dedi-

cated farmers and gardeners tried to develop so-called farm varieties particularly well suited to their growing conditions by constant reproduction.

In the biodynamic sector special importance has been attached to seeds at all times. In 1922/23 various farmers approached Rudolf Steiner, the later originator of biodynamic agriculture, and asked him for advice regarding the increasing degeneration of seeds that they believed to observe. The question was raised what to do in order to stop the breakup of seeds' and nutritional quality. This was the onset to address questions of care of seeds and maintenance of varieties as well as to engage in new breeds. Further aspects accrued when in 1924 Steiner held the so-called "Agricultural Lecture". Based on this background it is understandable why – long before legal regulations regarding the use of organic seeds have been developed – some farmers and gardeners keep busy in this area so strongly.

In 1985 the „Initiativkreis für Gemüsesaatgut aus biologisch-dynamischem Anbau“ was founded by a group of market growers in Germany, then and now mainly "Demeter" (for details of this network see also Petra Boie's contribution within the present proceedings). The Initiativkreis's principle task was and still is the supply of the organic sector with organically propagated seeds. Furthermore, some of the seed producers of this circle worked on the amelioration of the available varieties. In order to coordinate these on-farm breeding activities eventually the charitable association Kultursaat was established in 1994. Meanwhile well over 36 new breeds have been accepted for National List by the Federal Office of Plant Varieties (Bundessortenamt). The association is registered as maintenance breeder for 12 more varieties and at present, 15 new candidates are in official assessment (May 2009).

### **Outline of RODELIKA's biography – A story of qualitative enhancements**

For processing for organic carrot juice in Germany the open pollinating variety Rothild (Red Giant group) is widespread since a long time (Wistinghausen 1990). This variety was contract grown for many years at Dottenfelderhof near Frankfurt on the Main, a farm cultivated according to Demeter standards since 1968. Those stocks on this mixed biodynamic farm were the basis for propagation and selection of the new variety by the gardener and breeder Dietrich Bauer. In 1985 followed the decision in favour of one of the breeding lines, which then through systematic selection led to the candidate that was approved as a stand-alone variety with the denomination Rodelika by the Bundessortenamt in 1998. Based on mission-statement of ABDP (Association of biodynamic plant breeders eV), which can be found on its website, Demeter eV developed standards for biodynamic plant breeding and put them into action in January 2009. On this basis RODELIKA has been certified as a carrot variety which originates from biodynamic breeding.

Up to 1990 the carrots were solely selected for field health, morphological characteristics and colour. From then on the specifically developed and so-called sensory selection was pursued. PESCHKE (1994) documented these first steps and detected a significant increase of the sucrose content. Even though no analytics had been applied during the development time of RODELIKA, the breeding progress in the form of higher sugar contents and a closer ratio of mono- and disaccharides in comparison to the original variety confirms the capability of this breeding method (Hagel 2000, Fleck et al. 2002, Ulrich et al. 2004).

Within the value analysis of the Bundessortenamt 1998/99 RODELIKA was convincing through an overall high quality and remarkably good flavour (HEINE 2000). With quality examinations by picture forming methods RODELIKA has repeatedly scored as an excellent carrot (e.g. Fleck et al. 2002).

Initially when breeding for taste few satisfying specimen were obtained, namely 10 % of the pre-selected elite roots. From the fourth generation onwards 40 % of the elite roots were used for further breeding. Stringent selection in the process of maintenance breeding led to the rejection of only every third or fourth elite carrot due to faulty taste.

German processors of Demeter carrot juice use the special sensory quality to blend with other varieties to “tune” and also to specially process and market “true-to-variety juices” (Olbrich-Majer 2009; fig. 1).



Figure 1. RODELIKA carrots are available as fresh carrots (A) and as juice (B) – both labelled as true-to-variety products.

### Course of maintenance breeding today

Before sensory selection any single taproot is checked for outer traits including: average taproot length, shape of taproot (conical vs. cylindrical), shape and appearance of top of taproot (rounded shoulders, green skin), type of nodality (hollow vs. flat), strength, length, shape and colour of leaves, roughness of petioles, inner appearance (colour) of the cut taproot. Shape and proportions (e.g. root to shoot ratio) are relevant aspects that are taken into account for the overall impression to gain balanced and well-crafted plants (Hagel 2003).

The quality improvement went along with a reduced gross yield compared to the original variety (Fleck et al. 2001). This correlation is widely known (e.g. Banga 1954, Röbbelen 1976, Luby and Shaw 2009) and from 2000 onwards led to increased effort into such traits as size, length and mass of single taproot.

### Sensory selection in particular

After the morphological selection the remaining roots are examined for their sensory quality. Hereby samples are taken from the centre section of the carrots and individually tasted by a panel of about 5 trained people; with variety trials sensory work is done on the base of 10 taproots per plot. Special attention is paid to sweetness and aroma which is evaluated through a 9-point scale (Table 1) with the higher scores being the preferred ones.

Accompanying the 9-point scale – for further differentiation – are taste perceptions such as nutty, aromatic, grassy, but also a few off-flavour attributes like soapy and bitter. Only roots that satisfy the panel with the desired levels of sweetness and aroma are then selected for transplanting the following season. Sensory attributes such as soapy taste, bitterness and (several other) off flavours are knock-out criteria. This rating scale has meanwhile also proved itself in a

parsnip breeding scheme of Kultursaat eV (Horneburg et al. 2009). For maintenance breeding of RODELIKA (elite seed production) about 1,500 roots are planted out annually after the above mentioned selection method.

SCORE	9	8	7	6	5	4	3	2	1
sweetness	very sweet, (long) lasting	sweet, (long) lasting	sweet	sweetish or quickly declining	very little or short	hardly sweet or short	absent	absent	absent
aroma	lusty, nutty, lasting, all- consuming	nutty, full- bodied, lasting	a) typical, not lasting; b) slightly nutty	a) short or late pleasurable b) late, slightly raspy	a) insipid b) slightly raspy c) slightly soapy	a) very insipid b) bitter, raspy, scratchy c) slightly soapy	a) little pleasurable b) unpleasantly bitter c) unpleasantly soapy	empty or very bitter or soapy	very bad or inedible

Table 1: Sensory rating scale for carrots using the example of sweetness and aroma.

### Independence from corporate interests

Varieties developed within the Kultursaat eV breeding process are not property of individuals or companies, but are carried by Kultursaat eV. By this they remain in public ownership: RODELIKA e.g. has been developed by Dietrich Bauer, but the charitable association – which also finances the breeding – owns all property rights. It is not aimed at creating breeds that maximise shareholder value, but ones that keep with the tenets of biodynamic farming and foster the specific product quality of organic foodstuff.

The fact that in biodynamic plant breeding exclusively open pollinating varieties are being developed is due to the realisation that results from this breeding method are perceived as being high quality products (Fleck 2006, Hagel 2008, Müller 2009). Furthermore biodynamic plant breeding puts itself in the centre of “crops’ evolution”: Crops evolved because generations of farmers and breeders could draw on existing resources such as landraces. With hybrid breeding, notably with use and transfer of CMS this well-proven principle (farmers’ and plant breeders’ rights) is ignored and put ad absurdum.

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