Studies on Biodiversity of *Fragaria vesca* L.

L. Wutzky[1], K. Olbricht[2], P. Scheewe[1], A. Ludwig[2], D. Ulrich[3]

Abstract

Our cultivated strawberry Fragaria ×ananassa Duch*. is a spontaneous hybrid between the wild American species* Fragaria virginiana Miller *and* Fragaria chiloensis (L.) Miller*. Due to funnel effects in a more than 250 years breeding history the search for important plant characteristics in wild species, for example* Fragaria vesca L*. is promising. There are some cultivars of* F. vesca *for example 'Rügen', 'Baron Solemacher' or 'Yellow Wonder'. Hybrids between the octoploid cultivated strawberry* Fragaria ×ananassa *and* F. vesca *are in the breeders focus since 1918 and resulted in the decaploid* Fragaria ×vescana R. et A. Bauer *with cultivars like 'Florika' cultivated as a meadow-type field.* F. vesca *is spread throughout Eurasia and North America with special ecological adaptations to the particular habitat.*

In the present work we investigated the biodiversity of 25 F. vesca *accessions representing the whole geographic distribution for this species. Subspecies, formae (alba and semperflorens) as well a hybrid on the subspecies level (nothomorph) were included. The* F. ×ananassa *cultivar 'Elsanta' was used for comparison. Different vegetative and generative characteristics were documented throughout the growing season including fruit parameters. Altogether high diversity in* Fragaria vesca *accessions could be observed. Implications for breeding purposes are drawn in this work.*

Keywords: *Fragaria vesca*, wood strawberry, genetic resources, breeding, biodiversity

Introduction

The genus *Fragaria* L. belong to the *Rosaceae* family and to the subfamily *Rosoidae*. Species of the genus *Fragaria* L. with different ploidy levels can be found all over the North Temperate Zone (Staudt, 1989). Some of the species have a small range of distribution while other are widely distributed. Wild strawberry species in Europe are the hexaploid *F. moschata* Duch. and the diploid *F. viridis* Duch., and *F. vesca* L. They all have edible fruits with an intensive flavour. One of the species with a wide distribution is *F. vesca* which is spread throughout Eurasia and North America with specific ecological adaptations to the particular habitat. Despite their small fruit sizes there are some cultivars developed for example 'Rügen', 'Baron Solemacher' or 'Yellow Wonder'. They are mainly cultivated for domestic use. Wild species are genetic resources which can be used to improve and widen the genetic background of crop plants. Therefore, the aim of this study was to investigate the biodiversity of different *F. vesca* accessions representing the whole geographic distribution of the species with a focus on possible hybridization with the octoploid cultivated strawberry *Fragaria ×ananassa*.

[1]L. Wutzky, P. Scheewe, University of Applied Science Dresden, Faculty of Agriculture and Landscape Management, Pillnitzer Platz 2, D-01326 Dresden, Germany, scheewe@pillnitz.htw-dresden.de

[2] K. Olbricht, Hansabred GmbH & Co. KG, Radeburger Landstrasse 12, D-01108 Dresden, Germany, k.olbricht@hansabred.org

[3] D. Ulrich, Julius Kühn Institute (JKI), Federal Research Centre for Cultivated Plants, Institute for Ecological Chemistry, Plant Analysis and Stored Product Protection, Erwin-Baur-Strasse 27, D-06484 Quedlinburg, Germany, detlef.ulrich@jki.bund.de

Material and Methods

For this study 25 *F. vesca* accessions of the collection of Hansabred representing the whole geographic distribution were available. Subspecies, formae (alba and semperflorens) as well a hybrid on the subspecies level (nothomorph) were included. The *F. ×ananassa* cultivar 'Elsanta' was used for comparison. Plants were one year old or older. Most of them were cultivated in open wooden boxes (size 0,85 x 07 x 0,15 m) and some accessions were planted in spring 2011 in the adjoining open field (Table 1) both with sandy loam. Different vegetative and generative characteristics were documented throughout the growing season. Phenological data were determined by using the BBCH-scale of Meier (2001) and as basis for description of all other characters the guidelines of the UPOV were used (Anonym, 2008).

Single fruit weight was calculated by counting and weighing all available fruit over the whole season. Fruit analysis was done with a mixed probe of all harvested fruit. For each parameter three repetitions per accession were used. From these results the mean values were calculated. Soluble solids (in °Brix) were determined as an indirect measurement for the sugar content (Quick Brix 60, Mettler Toledo, Germany). The acidity was determined as a citric equivalent by volumetric analysis with sodium hydroxid solution (0,1 molar) using an automatic titrator (METROHM 716 DMS Titrino, Germany).

Results

The different *F. vesca* accessions had a wide range for showing the first flowers. The beginning of flowering was 19th April 2011 for *F. vesca* ssp. *californica* x *F. vesca* f. *semperflorens* 'Golden Gate' from California and 27th of May 2011 for *F. vesca* ssp *vesca* 'Oslo' from Norway. 'Elsanta' started to flower at 27th of April 2011.

The fruit ripening started between 02nd of June 2011 and 21st of June 2011 regarding all 25 *F. vesca* accessions and therefore later than 'Elsanta' (31st of May 2011). The earliest accessions were 'Korsika', 'Großolbersdorf', 'Micrantha', St. 98,04-4 and St.94,13. The harvest ended between 14th of June 2011 ('Wallis Schweiz') and 28th of July ('Bjørnestigen'), in comparison with 'Elsanta' at 7th of July 2011. The fruit of the remontant cultivars 'Red Wonder' and 'Yellow Wonder' were not harvested any longer past the 28th of July. The colour shades of the fruits varied in the genus but even in one accession depending on the position of the fruit (in shadow, upper fruit side etc.). Fruit shape varied with predominantly conical, round and oblate shapes, whereas 'Elsanta' showed mainly conical shaped fruit. Fruit size as diameter was in the mean per accession between 8mm ('R1' and 'Multiplex') and 21mm (St.08/101) compared to 35mm for 'Elsanta'. Other accessions with a comparable fruit size as St.08/101 were 'Golden Gate', 'Red Wonder', 'Yellow Wonder', 'Kaiserpfalz Tilleda', 'Weimar', 'Böhmen', 'Süd Öland 1' and 'Oslo'. Single fruit weight ranged between 0,34g ('Micrantha', 'Wallis Schweiz') and 1,04g for 'Red Wonder'. 'Golden Gate' and 'Queen Ferry' were with 0,96g respectively 0,95g only little lower. For 'Elsanta' single fruit weight was 11,34g. The *vesca*-typical weak adherence of the calyx could be observed for all accessions. The values of solible solids ranged between 9° Brix to 12,7° Brix including 17 accessions with more than 10° Brix. For 'Elsanta' the lowest value with 8,8° Brix was maesured (Figure 1). Also the acidity was higher for most of the *F. vesca* accessions with 1% ('Korsika') to 1,9% ('Bjørnestigen') than for 'Elsanta' with 0,9% (Figure 2).

Discussion

Our cultivated strawberry *Fragaria ×ananassa* Duch. is a spontaneous hybrid between the wild American species *Fragaria virginiana* Miller and *Fragaria chiloensis* (L.) Miller. All three species are octoploid. During the breeding process genetic diversity is often reduced

resulting in so-called funnel effects with poor aroma patterns and lost resistances. Useful traits can possibly be found in other species of the genus *Fragaria* for example *F. vesca*. Hybrids between the octoploid cultivated strawberry *Fragaria ×ananassa* and *F. vesca* are in the breeders focus since 1918 (Kuckuck, 1980) and already resulted in the decaploid *Fragaria ×vescana* R. et A. Bauer with cultivars like 'Florika' cultivated as a meadow-type field (Bauer, 1993).

Regarding the different documented characteristics some of the accessions might be interesting for further use. The time of flowering and harvesting were altogether in the range of the cultivated strawberry. The remontant character of 'Yellow Wonder' and 'Red Wonder' is very interesting for breeding everbearers. The accessions 'Weimar' and 'Bjørnestigen' with a long harvesting period of about five weeks might also be interesting. A great diversity of forms of fruit could be observed between the accessions. Fruit size and fruit weight were also variable but never reached the size of the cultivated 'Elsanta'. Fruit sizes between 18mm and 21mm (St.08/101, 'Böhmen', 'Oslo' and 'Golden Gate') were the the highest for the *F. vesca*. They may be interesting for breeding for this aspect.

Table 1 *Fragaria vesca* accessions and *Fragaria xananassa* 'Elsanta' used in this study

No.	Accession	Name	Source
1	*F.vesca f. alba*	St.08/101	Gatersleben, Germany, via Staudt
2	F.vesca f. alba	'S.Queen Ferry'	Scotland, South Queen Ferry, (Edinburgh), UK, via Staudt
3	*F.vesca ssp.vesca*	St.94,13	Baikal-Region, Russia
4	*F.vesca ssp. bracteata*	St.98,04-4	Nass River, British Columbia, Canada
5	*F.vesca ssp. americana*	St.14324	Bot. Garden Montreal,Canada
6	*F.vesca f. semperflorens*	'Red Wonder'	Cultivar
7	*F.vesca f. semperflorens*	'Yellow Wonder'	Cultivar
8	*F.vesca ssp.vesca*	'Island'	Bot. Garden Rejkavik, Iceland
9	*F.vesca ssp.vesca*	'Kaiserpfalz Tilleda'	Saxony-Anhalt, Germany
10	*F.vesca ssp.vesca*	'Korsika'	Corsica, St. Bonifatius,1800m, France
11	*F.vesca ssp.vesca*	'Multiplex'	Pohlheim, Germany
12	*F.vesca ssp.vesca*	'Weimar'	Garden of J.W.v. Goethe in Weimar, Germany
13	*F.vesca ssp.vesca*	'Böhmen'	Bohemia, Stimmersdorf, near Prebischtor, Elbsandsteingebirge,Czech Republic
14	*F.vesca ssp.vesca*	'Tüchersfeld'	Franken, Germany
15	*F.vesca ssp.vesca*	'Süd-Öland 1'	Öland, Sweden
16	*F.vesca ssp.vesca*	'R1'	Nesselwang, Germany
17	*F.vesca ssp, vesca*	'Großolbersdorf'	Großolbersdorf (Ore Mountains), Germany
18	*F.vesca ssp, vesca*	'Rübeland'	Rübeland (Harz), Germany
19	*F.vesca f. alba*	'Moritzburg'	Moritzburg, near Dresden, Germany
20	*F.vesca ssp.vesca*	'Wallis Schweiz'	Wallis, Switzerland
21	*F. vesca ssp vesca*	'Bjørnestigen'	Bjørnestigen, Norway
22	*F. vesca ssp vesca*	'Oslo'	Oslo, Norway
23	*F.vesca ssp.californica x vesca f. semperflorens*	'Golden Gate'	Golden Gate, San Francisco, Californian, USA
24	*F. vesca ssp vesca*	'Finnland'	Suur-Saimaa, north of Lapeenranta, Finland
25	*F.vesca ssp.vesca*	'Micrantha'	Hamrafjället, Province Härjedalen, Sweden
26	*F. ×ananassa*	'Elsanta'	cultivar, hybridization between 'Gorella' × 'Holiday'; IVT Wageningen, Netherlands 1975

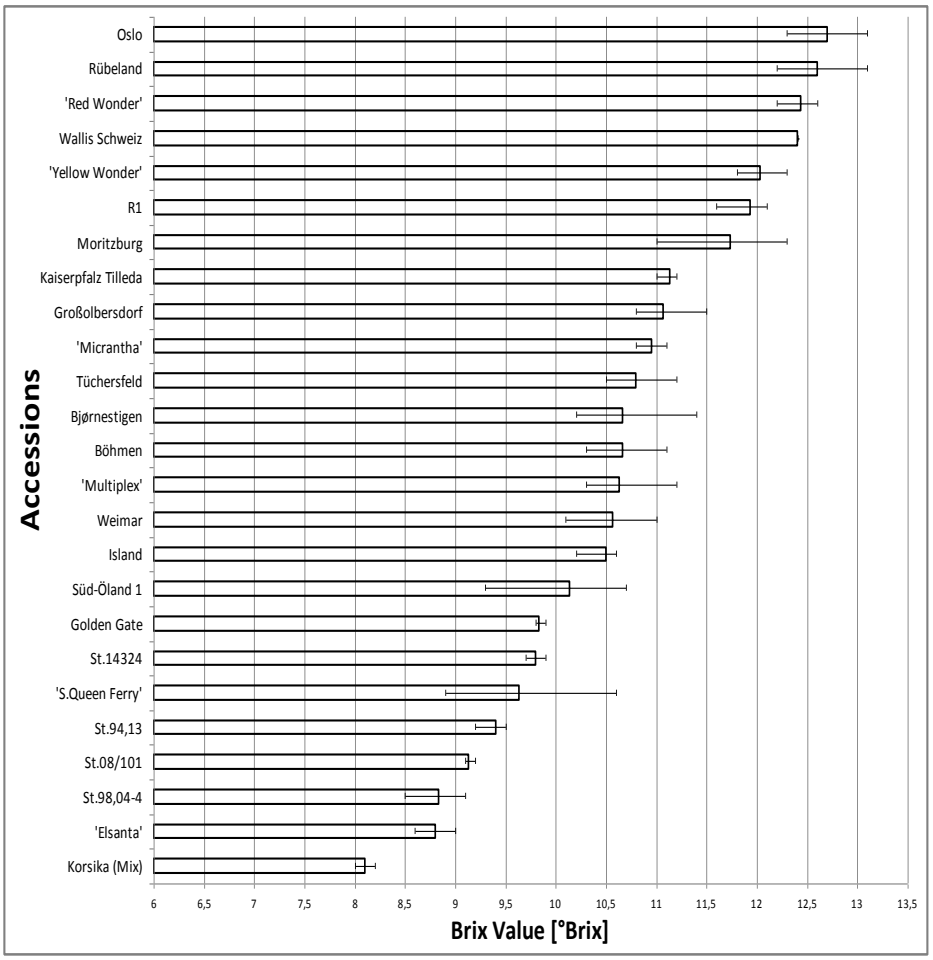

Figure 1: Mean value, max., min. of solible solids (°Brix) in strawberry fruit of 24 accessions of *F.vesca* and variety 'Elsanta'

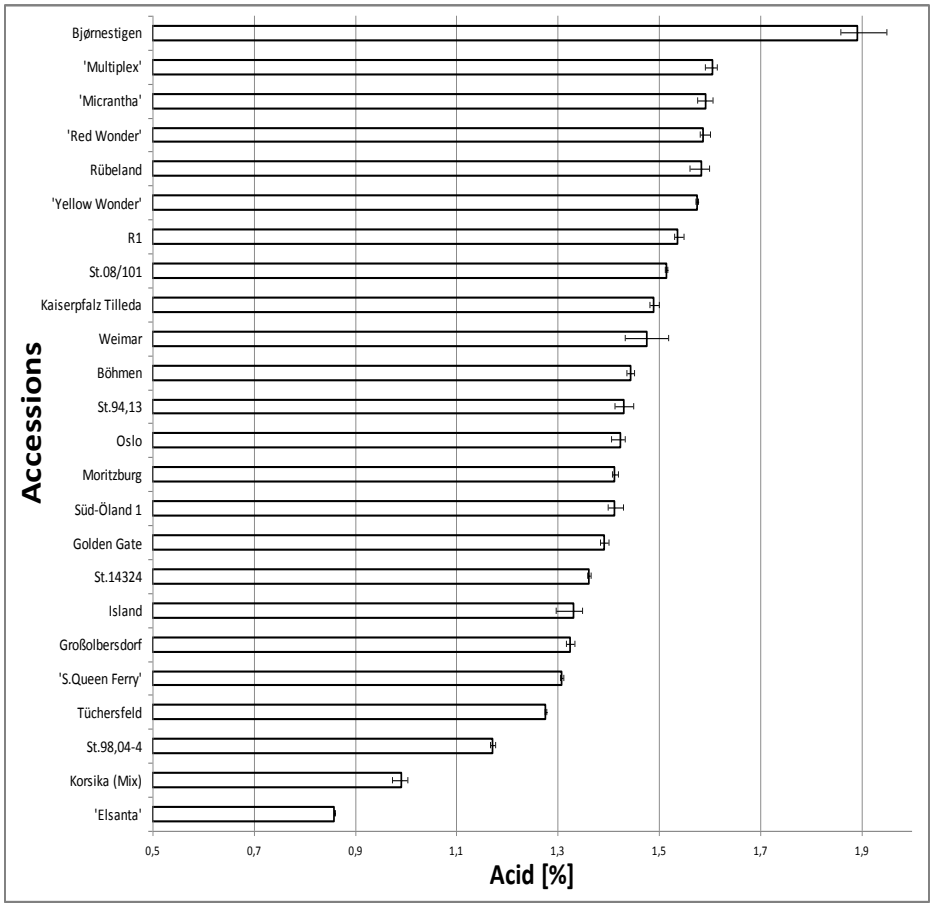

Figure 2: Mean value, maximum, minimum of percent acid in strawberry fruit of 23 accessions of *F.vesca* and variety 'Elsanta'

Important parameters for the flavour of a fruit are beside the aroma compounds and the mouth feeling the contents of sugar and acid and in particular the sugar/acid ratio. For sugar (measured as solible solids) and acid content the mean values were higher than the value for 'Elsanta' except the sugar content for 'Korsika'.

According to Duden (1992) sugar content should be more than 8°Brix for a good taste and more than 9° Brix for a very good taste. The latter was true for most of the *F. vesca* accessions. However for a good taste the sugar/acid ratio is also crucial.

F.vesca is known for exclusive aroma (Ulrich et al. 2007). Thus, it will be a good source for improving flavour of strawberry (Olbricht et al. 2009). The diversity of aroma patterns was measured additionally but is not topic of this paper. Two accessions are meanwhile included in breeding activities.

References

Anonym, (2008). Strawberry, *Fragaria* L., UPOV Code: FRAGA, Guidelines for the Conduct of Tests for Distinctness, Unifomity and Stability. UPOV TG/22/10, UPOV.

Bauer, A. (1993). Progress in Breeding Decaploid *Fragaria xvescana*. *Acta Hort.* **348**: 60-64.

Duden, R.; Wolf, W.; Braun, M.; Röckel, K. (1992). Der Brixwert, ein Mass für die geschmackliche Qualität von Erdbeeren. *Lebensmittel-Technologie* **25(12)**: 299–301.

Kuckuck, H., (1980). Elisabeth Schiemann 1881 bis 1972*. Bericht der Deutschen Botanischen Gesellschaft* **93**: 517-537

Olbricht, K.; Grafe, C.; Dunemann, F.; Würzburg, F.; Drewes-Alvarez, R.; Hoberg, E.; Ulrich, D. (2009). Breeding potential of *Fragaria vesca f. alba* in respect to volatile compounds. *Acta Hort.* **814**: 561–566.

Staudt, G. (1989). The species of *Fragaria*, their taxonomy and geographical distribution*. Acta Hort.* **265**: 23-34.

Meier, U. (ed.), (2001). Growth stages of mono-and dicotyledonous plants, BBCH Monograph. 2. Edition, Federal Research Centre for Agriculture and Forestry.

Ulrich, D., Komes, D., Olbricht, K., & Hoberg, E. (2007). Diversity of aroma patterns in wild and cultivated *Fragaria* accessions. *Genetic Resources and Crop Evolution* **54 (6)**: 1185-1196.