Mitteilungen Klosterneuburg 59 (2009): 199-208

Reconstructing the heritages of 'Grüner Veltliner' and 'Sauvignon blanc' from crossings with 'Traminer' by SSR analyses

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'Grüner Veltliner' is the main variety in Austrian viticulture. About 30 % of the national production is obtained from this grapevine. Due to the importance of the variety for the Austrian production it is not satisfying to define its origin only as traditional and unknown. By means of more than 120 SSR markers it was feasible to confirm the parentage of the variety 'Traminer'. Fortuitously we could recognize the second parent of 'Grüner Veltliner'. But this grapevine survived as a single plant without a name and still without reference vine therefore still nameless. Concerning the phenotype this unnamed variety seems to be more similar to 'Grüner Veltliner' than to 'Traminer', the other parent. Huge worldwide importance is attributed to the variety 'Sauvignon blanc'. In France more than 25000 ha are planted with 'Sauvignon', in oversea countries like New Zealand, Australia and others acreages are increasing. The origin of the variety was not clear and even the heritage was unknown. Numerous SSR analyses allowed to recognize the parentage as a cross of 'Traminer' x 'Chenin blanc'. So 'Traminer' could be determined once more as parental vine of a high quality grapevine variety. 'Traminer' seems to be one of the key varieties for the development of the Mid European diversity of grapevine.
Keywords: heritage, clones of grapevine, genetic analysis, SSR markers, origin, outcrossing

Ermittlung der Abstammung von 'Grüner Veltliner' und 'Sauvignon blanc' als Kreuzungen von 'Traminer' mit SSR-Analysen. *'Grüner Veltliner' ist die wichtigste Sorte des österreichischen Weinbaus. Über 30 % der heimischen Produktion stammen von dieser Sorte. Bei dieser überragenden Stellung der Sorte ist als Herkunftsangabe die Verwendung als traditionelle Rebsorte und deren unbekannte Herkunft nicht zufriedenstellend. Mittels Mikrosatellitenanalyse wurden über 120 Genorte untersucht, um die Beziehung der Rebsorte zur vermuteten Herkunft aus einer Traminer-Kreuzung zu überprüfen. Durch Zufall konnte mittlerweile eine zweite Rebe als Elternsorte identifiziert werden. Diese Rebe konnte bisher keiner bekannten Sorte zugeordnet werden, was eine genaue Bezeichnung mit einem Sortennamen verhindert hat. Ampelographische Untersuchungen zeigten, dass diese Rebe phänotypisch der Sorte 'Grüner Veltliner' ähnlicher ist als die andere Elternsorte 'Traminer'. Eine sehr große Bedeutung hat für Frankreich die Sorte 'Sauvignon blanc'. Es sind zur Zeit ca. 25.000 ha mit der Rebe alleine in Frankreich bestockt. Insbesondere Neuseeland, Australien und anderen Überseeländern ist die Tendenz steigend. Die Herkunft und Abstammung der Sorte lag ebenfalls im Dunkeln und konnte nunmehr durch zahlreiche Analysen mittels SSR-Markern als eine Kreuzung zwischen 'Traminer' und 'Chenin blanc' identifiziert werden. Damit erweist sich einmal mehr die Sorte 'Traminer' als eine Schlüsselsorte zur Entwicklung der heutigen Rebsorten.*
Schlagwörter: Abstammung, Rebklone, Genetische Analyse, SSR-Marker, Herkunft, Auskreuzung

Détermination de l'origine du 'Grüner Veltliner' et du 'Sauvignon blanc' en tant que croisements de 'Traminer' à l'aide d'analyses SSR. *'Grüner Veltliner' est le cépage le plus important de la viticulture autrichienne. Plus de 30 % de la production nationale proviennent de ce cépage. Vu le positionnement exceptionnel de ce cépage, il n'est pas satisfaisant que la déclaration d'origine mentionne l'utilisation en tant que cépage traditionnel et son origine inconnue. Plus de 120 loci ont été examinés par voie d'analyse des microsatellites afin de vérifier si le cépage est réellement*

issu d'un croisement du Traminer, son origine présumée. C'est par hasard qu'une deuxième vigne a pu être identifiée comme cépage parent entre-temps. Jusqu'à présent, cette vigne n'a pu être attribuée à aucun cépage connu, ce qui a empêché sa désignation exacte par un nom de variété. Les essais d'ampélographie ont montré que, du point de vue du phénotype, cette vigne ressemble plus au cépage 'Grüner Veltliner' que l'autre cépage parent, le 'Traminer'. Pour la France, le cépage 'Sauvignon blanc' est d'une très grande importance. À l'heure actuelle, rien qu'en France, cette vigne est cultivée sur près de 25 000 ha. La tendance est à la hausse, notamment en Nouvelle-Zélande, en Australie et d'autres pays d'outre-mer. L'origine et l'ascendance du cépage étaient également incertaines et le cépage a pu être identifié récemment à l'aide de nombreuses analyses au moyen de marqueurs SSR comme un croisement entre le 'Traminer' et le 'Chenin blanc'. Par là, le cépage 'Traminer' se révèle de nouveau être un cépage-clé dans le développement des cépages modernes.
Mots clés: Ascendance, clones de vignes, analyse génétique, marqueurs SSR, origine, croisement

The grapevine variety 'Grüner Veltliner' contributes about 30 % to the national grape production of Austria. Therefore this variety is the most important one for Austrian winegrowers (Ambrosi et al., 1994). In some of the viticultural areas like Kremstal and Kamptal 75 % of the total area are planted with 'Grüner Veltliner'. (www.weinausoesterreich.at). Besides the 16700 ha in Austria it should be mentioned that there are about 4000 ha in Slovakia, 2000 ha in Hungary and 1800 in the Czech Republic as well as small areas in Italy (Regner, 2007). These data show that 'Grüner Veltliner' has to be accounted one of the important varieties of Europe. Cultivation of 'Grüner Veltliner' was even started at Umpqua Valley in the U.S. (www.wine.appellationamerica.com).

The variety is known as traditional with unknown origin. It was confirmed that from the botanical point of view the synonym 'Weißgipfler' would better describe morphologic characteristics of the vine. In former studies it could be recognized that the variability within the 'Grüner Veltliner' variety is not as high as estimated before (Regner et al., 2008).

The name 'Grüner Veltliner' is rather young and didn't exist at the beginning of the 19th century. Former designations of this variety were 'Weißgipfler' or 'Grünmuskateller'. Babo and Mach (1881) defined the variety as 'Grüner Veltliner' for the first time. But it seems that the designation was of sufficient quality to recognize the variety and to confirm that the former names were true synonyms. From the botanical point of view 'Grüner Veltliner' is not a genuine Veltliner variety and the better denomination would be the synonym 'Weißgipfler'.

Goethe (1887) favoured 'Weißgipfler' as the correct name for this variety. Comparing it with 'Rotgipfler', both varieties seem to be closely related as both show 'Traminer' as a parental plant. But why is this variety called 'Veltliner'? The reasons remain unclear. One could be the wrong definition of this variety as a green-berried type of the variety 'Roter Veltliner' in the 19th century. There are also white- and brown-berried types of 'Roter Veltliner'. Especially the brown-berried type was widespread and in former times one of the most important grapes for the local viticulture. In some regions growers call the variety "Österreicher" as it was very popular in Austria. The grapevines 'Brauner Veltliner' and 'Grüner Veltliner' look very similar under certain circumstances. That was the reason for mixing them up without noticing the mistake. Nevertheless the variety 'Roter Veltliner' is the original one and is placed at the centre of this family. When in books before the 19th century the name 'Veltliner' was mentioned, it always meant 'Roter Veltliner'. Babo and Mach (1881) declared that the misnaming was already spread so far that they didn't want to change anything despite their better knowledge.

About the heritage no knowledge was available beside the wrong parentage of 'Roter Veltliner'. We have sufficient information about the area where 'Grüner Veltliner' was cultivated in the 19th century. The variety sometimes was planted despite the ban by the local nobles.

Burger (1837) was convinced that the centre of the cultivation of this variety (he called it Plinia austriaca) was located north of the Danube in the area around Retz, especially within the villages Pulkau, Zellerndorf, Haugsdorf and Stinkenbrunn but also along the roads to Brünn and Horn. There the vineyards were planted with only one variety although it was usual at that time to mix different varieties in the same vineyard. It is amazing that Burger (1837) included the variety in one family with 'Rotgipfler' and 'Rheinriesling'. Both varieties show according to today's knowledge a parentage of 'Traminer'.

Schams (1832), who reported about the guidelines for viticulture in the city of Pressburg in 1804, mentions

an appeal of the mayor of the town to avoid cultivation of 'Grünmuskateller' (synonym of 'Grüner Veltliner') as it was considered to be a mass producer with low wine quality. He also mentioned that the name 'Muskateller' has nothing to do with true 'Muskat' varieties. Moreover the question arose if 'Grünmuskateller' was an individual variety and not identical to 'Grüner Veltliner'. It also was supposed that 'Grünmuskateller' was an ancient type of today's variety. Due to the relatively low variability within the variety it can be supposed that the variety is much younger than other traditional varieties (Hack, 2007). Some morphologic differences are caused by phytosanitary status and occurrence of specific endophytes in plant material.

Firstly 'Grünmuskateller' was mentioned by Sprenger (1766) as a variety derived from Ödenburg but with shallow description, which made identification impossible. Older designations of the 'Veltliner' variety lack quality in description for attributing the name to on of today's varieties. In most cases it is not clear if they meant the variety, the wine or the region Valtellina in Italy. It was also tried to find varieties related to 'Veltliner' in this Italian region, but without any success.

Just alike the origin of 'Sauvignon blanc' is also unknown. It is supposed that Central France or Bordeaux could be the place where this variety was selected. According to historical literature the naming of the variety was a persistent confusion. The separation from 'Savagnin' (French synonym for 'Traminer') was not performed in a satisfying manner.

Therefore clear definition happened very late in the 19th century. Probable synonyms of 'Sauvignon' were 'Sauvagnin' (Rendu, 1857), 'Sauvagnien' (Chevalier, 1860), 'Sauvoignin' (Jullien, 1832), and 'Sauvagneux' (Odart, 1862) and others. Odart (1862) tried a clear differentiation for the first time and concluded that these both varieties were not closely related. Viala and Vermorel (1909) mentioned all types (vert, jaune, petit, fumé, rose and violet). It seems that the special flavour of 'Sauvignon' was not appreciated very much, as wines with strong "sauvigonne" were blended in cuvée wines. Bowers and Meredith (1996) at the UC Davis recognized by means of RFLP analysis the close relation of 'Traminer' and 'Sauvignon'. In this study these two varieties show highest homology (about 93 %) among all involved varieties. Under these circumstances 'Sauvignon' also could be traced back to mutations of 'Traminer'. Nevertheless only areas where 'Traminer' ('Savagnin') was grown in the past can be assumed as geographical origin. Especially the viticultural regions of the Jura, Loire and Alsace are candidates for the origin, but not Bordeaux or Sauternes.

For the Austrian production it can be confirmed that the variety was firstly planted for an economic wine production to a greater extent during the time of reestablishing the vineyards to avoid Phylloxera damage. Trummer (1841 and 1855) did not mention the variety when he created his ampelographic description of the varieties used for Styrian wine production. He mentioned the variety 'Muscatsylvaner' (synonym of 'Sauvignon blanc') for the French production. Even Goethe (1887) did not count 'Sauvignon' as an important variety for Styria. In a collection of ampelographic watercolour paintings created around 1850 (published recently as a reprint) and presenting most of the varieties common in Styria and Slovenia no pictures are available for 'Sauvignon' (Kreuzer and Kreuzer, 2001). Therefore the Austrian production of 'Sauvignon' is not older than one hundred years, but today it is of increasing importance for the cooler regions. It is supposed that canes were brought from France for reestablishing vineyards after phylloxera had devastated them.

The aim of this work was to verify the heritage of 'Grüner Veltliner' and 'Sauvignon blanc' from 'Traminer' and even to define the second parental variety. Nowadays identification of grapevine genotypes is done by genetic fingerprints (Thomas et al., 1993). The method is sensitive for differentiation, but stable enough to reproduce data under different conditions (This et al., 2004). Therefore in the meantime the easiest way to identify unknown varieties is to compare the genetic profile to existing data of different collections (Vosman et al., 2001; This et al., 2004). In some cases it has already been possible to show how identification of clones could function (Techera et al., 2004; Regner et al., 2006)

Material and methods

Plant material of all involved varieties is kept at the Department for Grapevine Breeding at the Educational and Research Centre for Viticulture and Pomology in Klosterneuburg. The material originated from different locations of Europe, especially samples of 'Chenin blanc' and 'Sauvignon' were of French origin. The vine from St. Georgen had been found at an unproductive place (used for the cultivation of vines not later than the 16th century) on slopes of the Leitha hills. It is a relict of former times and due to several dead trunks it

seems realistic that this vine has derived from that time. Maybe the sandy soil kept off phylloxera and bushes and trees have protected the leaves against mildew diseases.

The morphology of the vines was evaluated according to the O.I.V descriptors (Anonymous, 1983) and data were compared for their pronounced morphology.

DNA from vines was extracted from young leaves by following the protocol described by Thomas et al. (1993) and modified by Regner et al. (1998). The varieties involved in this study were analysed at least with 36 SSR markers.

The VVS markers were developed by Thomas and Scott (1993) and the VVMD markers by Bowers et al. (1996) as well as by Bowers et al. (1999). The VRZAG markers (Sefc et al., 1999) and all other markers were used from the "Vitis Microsatellite Consortium" collection designated with internal coding of the consortium. Amplification was performed in 20 µl of the buffer solution, which consisted of 16 mM $(NH_4)_2SO_4$, 67 mM Tris-HCl pH = 8.8, 1.5 mM $MgCl_2$, 0.01 % Tween 20, 0.1 mM each dNTP (GenXpress, Maria Wörth, Austria), 0.2 µM primer, 1 Unit SAVADY Taq DNA polymerase (Peqlab, Erlangen, Germany), and 50 ng genomic DNA of grapevine.

A Mastercycler (Eppendorf, Hamburg, Germany) thermocycler processed 36 cycles for SSRs. The amplification of the SSR loci was performed by following our general protocol but by applying specific annealing conditions. The general PCR protocol applied for these studies was 2 min. denaturation at 94 °C and 35 cycles with annealing phase for 30 sec. (temperature between 45 °C and 55 °C) and denaturation for 15 sec. at 92 °C. The annealing temperature for each locus was set according to the Tm - 10 °C temperature. A final extension of the fragments was performed at 72 °C for 5 min. Due to the different size range of the involved loci multiplex PCR was feasible. At least the alleles of three loci were separated on one sequencing gel.

Yield of DNA fragments was estimated by running an aliquot of the sample on a 2 % agarose gel stained with ethidium bromide. The samples were denaturated by heating up with formamide and loaded together with a size standard (Genescan 350 Tamra, Appl. Biosystems, Warrington, Great Britain) to a 6 % polyacrylamid gel. Detection of the SSR fragments labelled with the fluorescent dyes 6FAM, TET and HEX was carried out by an automated sequencer (ABI 373, Perkin-Elmer, Vienna). Labelling with these different fluorescent colouring agents facilitated the application of multiplex PCR.

Results

The genetic profile of 'Traminer' and 'Grüner Veltliner' share one allele at each locus, and therefore the conclusion that they have a close genetic relationship can be drawn (Table 1). From the morphologic point of view they differ more than it can be supposed from closely related varieties (Table 2). Therefore it was estimated that the second parent of 'Grüner Veltliner' dominated the ampelographic character. But the second parent could been found neither within the 'Veltliner' family nor within the collection of old and rare varieties kept within the collection of Klosterneuburg. By luck an ancient vine from St. Georgen near Eisenstadt was genotyped and this variety seems to be the missing part of the origin of 'Grüner Veltliner' (Table 1). Nevertheless the genetic profile of this variety could not be confirmed from any other of the numerous collections in Europe. The profile was source of comparison of unknown varieties within the project Grapegen 06 but none of the participating collections found closer similarities to known varieties. At that moment we can define the variety as an unknown variety. 244 alleles were obtained by genotyping 'Grüner Veltliner' and the unknown variety from St. Georgen at 120 loci. Only the markers not amplified in all involved varieties were excluded from the studies. 'Grüner Veltliner' and the unknown variety from St. Georgen shared 144 identical alleles. The differences are strong enough to exclude mutations as the source of 'Grüner Veltliner'. On the other hand they share almost at each locus one allele what confirms the hypothesis of hybridization with 'Traminer'. It could be shown for all 19 chromosomes that the proposed heritage is supported by the segregating alleles. Nevertheless some loci also exist that could not satisfy the criteria for a perfect heritage (Table 1a) but do not reach 10 % of the loci. Nevertheless our experiences from documented crossings have shown that deviations from the parental alleles increase in combinations of genotypes with larger differences. As the unknown variety from St. Georgen shows more different alleles, it could be that adaptation happened during recombination. One of the alleles at VVMD 6 and at VVMD 32 are unique and could not be observed within all these thousands of varieties analysed so far. One allele at the loci VRZag 15 and VRZag 62 is rare and usually found in non *V. vinifera* varieties.

In the meantime we successfully tried to propagate the material because of the risk of losing the whole genotype due to the age of the single remaining vine. Fur-

Table 1: Genetic profile of 38 SSR loci (two per chromosome) arranged according to the chromosome number. The coincidence at numerous loci allows to designate the hypothesis of the heritage of 'Grüner Veltliner' as a cross of 'Traminer' x unknown variety of St. Georgen.

Chrom. Nr.	locus	Tra	Tra	GV	GV	St. Georgen	St. Georgen
1	VVS29	168	168	168	168	168	168
1	VVMD 26	249	251	251	251	251	251
2	VVS3	212	218	212	212	212	218
2	VMC 6f1	145	150	145	150	145	150
3	VMC 8f10	201	236	201	236	217	236
3	VVMD 36	252	262	252	262	252	262
4	VrZag 83	188	200	194	200	194	200
4	VMC 7h3	145	175	145	175	152	175
5	VVMD 14	228	238	228	228	224	228
5	VVMD 27	188	188	188	193	184	193
6	VVS5	105	120	105	120	105	120
6	VVMD 21	248	248	242	248	242	248
7	VVMD 6	199	206	189	199	162	189
7	VVMD 7	240	254	244	254	240	244
8	VVS4	167	174	166	174	166	-
8	VMC 2h10	110	-	110	115	115	117
9	VMC 2e11	145	150	145	150	145	152
9	VMC 3g8.2	162	175	160	175	-	175
10	VrZag 64	139	163	139	143	139	143
10	VrZag 67	126	132	126	159	154	159
11	VVS2	150	150	132	150	132	142
11	VVMD 8	138	140	140	144	138	144
12	VMC 4a9	350	350	350	350	350	350
12	VMC 4h9	170	230	170	230	170	230
13	VVS1	161	189	161	180	161	180
13	VMC 3d12	220	230	210	220	-	220
14	VVMD 24	211	216	211	216	207	211
14	VrZag 112	234	242	234	242	234	-
15	VMC 4d9.2	241	-	241	-	241	-
15	VMC 6e10	112	117	95	117	95	121
16	VVMD 5	230	236	230	230	230	234
16	VMC 4b7.2	325	330	330	350	320	350
17	VrZag 15	165	165	165	165	165	195
17	VMC 3a9	104	110	104	104	104	112
18	VVMD 17	220	220	220	222	220	222
18	VMC 8e6	260	290	260	290	240	260
19	VMC 3b7.2	95	95	95	95	95	98
19	VVIP 31	181	195	181	181	181	187

Table 1a: SSR loci which could not support the proposed parentage of 'Grüner Veltliner'

Chrom. Nr	Locus	Tra	Tra	GV	GV	St. Georgen	St. Georgen
19	VVIP 17	88	95	90	95	93	95
14	VMC 2c3	175	180	175	185	172	175
8	VMC 1f10	202	216	202	206	202	212

thermore we are curious to harvest first grapes and compare them with ’Grüner Veltliner’ grapes. The mature leaf of St. Georgen is very similar to the morphology of ’Grüner Veltliner’ leaves (Fig. 1) but the main differences could be found at the shoot tip colour (Fig. 2). While ’Grüner Veltliner’ lacks anthocyanins at the buds and at the shoot tip St. Georgen vines produce a high amount of them (Table 2).

The second parentage we currently investigated was the origin of ’Sauvignon blanc’. Due to the high degree of

Table 2: OIV-descriptors of 'Grüner Veltliner', 'Traminer' and the variety from St. Georgen; the values of the descriptors are explained in the OIV-catalogue of descriptors.

OIV-Nr.	Descriptor	Traminer	Grüner Veltliner	St. Georgen
	Young shoot			
001	Form of tip	7	7	7
003	Intensity of anthocyanins of tip	3,5	3	5
004	Density of prostrate hairs	3	7	3
	Shoot			
006	Attitude	3	3	3
007	Colour of dorsal side	2,3	1	3
008	Colour of ventral side	1	1	1
015-1	Distribution of bud anthocyanins	5,7	1	7
015-2	Intensity of bud anthocyanins	5	1	7
016	Distribution on the shoot	1	1	1
	Young leaf			
051	Colour of the upper side	3	1	1
053	Density of prostrate hairs	7	7	3
	Mature leaf			
067	Shape of blade	3,4	3,4	3
068	Number of lobes	2,3	3,4	3
070	Coloration of main veins	3,4	1,2	3
072	Goffering of blade	1,3,5	3	1,3
074	Profile	4	1,4	1
075	Blistering of upper side	5,7	3,5	1
076	Shape of teeth	4	3	3,4
079	Shape of petiole sinus	2,3,6	3,4	3,5
080	Shape of base of petiole sinus	3	3	1
081-1	Teeth in petiole sinus	1,2	1,2	1
081-2	Petiole sinus base limited by vein	1	1	1
083-2	Teeth in upper lateral sinuses	1	1	1
084	Density of hairs between the veins	3,5	5	3
087	Density of erect hairs on veins	5,7	3	1
	Grape bunches			not available
151	Sex of flower	3	3	not available
202	Bunch length	1,3	3,5	not available
204	Bunch density	3,5	5	not available
206	Length of peduncle	1,3	3	not available
208	Bunch shape	2	2	not available
209	Number of wings	1,2	2,3	not available
220	Berry length	3,5	3,5	not available
221	Berry width	3	3,5	not available
503	Single berry weight	3	1,3	not available
223	Berry shape	2	2,3	not available
225	Colour of skin	1,2,3	1	not available
230	Colour of flesh	1	1	not available
236	Particular flavour	5	5	not available
241	Presence of seeds	3	3	not available

same RFLP (Bowers and Meredith, 1996) fragments it was supposed that 'Traminer' is a parental vine of 'Sauvignon'. Furthermore it also could be that 'Sauvignon' is a mutated type from 'Traminer' ('Savagnin'). We developed 105 SSR loci (partly shown in Table 3) and obtained 220 alleles for 'Sauvignon' but 65 differed from alleles from 'Traminer'. Within several 'Traminer' types (also 'Savagnin') we detected with the same loci 12 different alleles. But it seems that we are still able to exclude mutations of 'Traminer' as the origin of 'Sauvignon'. Besides the convincing number of alleles we should find in that case additional types closer to 'Sauvignon'. From all other varieties with chance to be a parental type of 'Sauvignon' only 'Chenin blanc' remained. Especially 'Semillon', 'Muscadelle' and 'Sauternes blanc' were involved in this study but their profiles ex-

Table 3: Genetic profile of 38 SSR loci (two per chromosome) arranged according to the chromosome number. The coincidence at numerous loci allows to propose a hypothesis about the heritage of 'Sauvignon' from a cross of 'Traminer' x 'Chenin blanc'.

Chrom. Nr.	Locus	Chenin blanc	Sauvignon rose	Traminer
1	VRZag 29	112	112 : 116	112 : 116
1	VMC 3g9	170, 172, 175	170 : 175	172 : 175
2	VVS 3	212 : 218	212 : 218	212 : 218
2	VMC 5g7	210 : 230	210 : 230	230
3	VVMD 28	236 : 250	234 : 236	234 : 236
3	VVMD 36	262 : 268	262 : 262	252 : 262
4	VVMD 32	256 : 271	239 : 256	239 : 271
4	VRZag 21	200 : 204	204 : 206	200 : 206
5	VVMD 14	218 : 238	218 : 228	228 : 238
5	VVMD 27	174 : 188	174 : 188	188
6	VRZag 30	147 : 151	149 : 151	149 : 151
6	VVS 5	105, 125, 160	110, (125), 160	110, 125,160
7	VVMD 6	199 : 206	199 : 206	199 : 206
7	VVMD 7	236 : 254	236 : 254	240 : 254
8	VVS 4	168 : 172	167 : 168	167 : 174
8	VMC 6g8	90 : 105	105	100 : 105
9	VMC 1c10	165 : 185	165 :185	155, 170, 185
9	VMC 4h6	180 :195	180 : 195	180
10	VRZag 64	143 : 163	139 : 143	139 : 143
10	VRZag 67	132 : 149	126 : 149	126 : 132
11	VVS 2	132 : 150	132 : 150	150
11	VVMD 8	138	138 : 140	138: 140
12	VMC 8g8	161 : 187	187 : 222	161 :199
12	SCU 5	170 : 175	175 : 185	170 : 185
13	VVS 1	161 : 180	180 : 189	161 : 189
13	VVIP 10	280, 300, 320, 340	280, 300, 320, 340	300 : 340
14	VVMD 24	211 : 216	215 : 216	211 : 215
14	VRZag 112	234	234 : 240	234 : 240
15	VVMD 30	105 : 115	105 : 115	105 : 150
15	VMC 8g3	340 : 380	340 : 380	370 : 380
16	VVMD 5	226 : 230	226 : 230	230 : 236
16	VMC 4b7.2	295 : 300	295 : 302	295 : 302
17	VRZag 15	165	165 : 165	165
17	VMC 3a9	110	80 : 110	80
18	VMCNG 1b9	155: 161	155 : 161	161 : 165
18	VVIP 08	60	60 : 65	60 : 65
19	VVIN 74	305 : 330	330	305 : 330
19	VVIP 17	80 : 95	95	78 : 95

Table 3a: SSR loci which could not support the parentage of 'Sauvignon blanc'

Chrom. Nr.	Locus	Chenin blanc	Sauvignon rose	Traminer
1	VMC 1d10	210	210	205
5	VRZag 26	110	110 : 160	110
8	VMC 2h10	115 : 120	115 : 145	115
12	VMC 8g8	161 : 187	187 : 222	161 : 199

Figure 1: Mature leaves of 'Grüner Veltliner' (right leaf) and St. Georgen in comparison

Figure 2: Shoot tip of 'Grüner Veltliner' (right shoot) and St. Georgen in comparison

clude a parentage for 'Sauvignon'. It was surprising that from the 220 alleles 'Chenin blanc' shared 129 with 'Sauvignon' while 'Traminer' only reached 115 identical alleles. But there are also some alleles which could not be covered by one of the both parental genotypes, but they do not exceed 10 %. On the other hand we also found some differences between 'Sauvignon jaune', 'blanc' and 'rose' at 6 loci. That means in contrary to 'Grüner Veltliner' the variability within 'Sauvignon' seems to be much higher. Finally we postulate for 'Sauvignon blanc' the parentage of 'Traminer' x 'Chenin' but with some minor changes that happened during hybridization or mutations during former propagation. In this case we are not able to offer a perfect heritage but no other combination shows higher coincidence with the allelic profile of 'Sauvignon'.

Discussion

The heritage of traditional varieties was the objective of numerous studies. On the one hand it is helpful to know the descent of today's varieties, on the other hand it is important for future breeding strategies to know all about their base. Since grapevine is an ancient crop and has been used for viticulture for several thousands of years numerous selection steps were necessary to reach the level of today's production. Some of the developments now can be followed, others are still unknown or simply generalized. We know that the diversity of *Vitis vinifera* has two reasons. One is the selection out of wild vines in all viticultural regions of Europe and the second is the continuous improvement of material by man (MULLINS et al., 1990). In several varieties of the moderate European climate zones 'Traminer' parentage could be verified. That means that 'Traminer' is one of the key varieties for the development of grapevine diversity. Besides the here presented varieties also 'Silvaner', 'Rotgipfler', 'Pinot' and 'Riesling' show 'Traminer' outcrossing behaviour (REGNER, 2000). Further key varieties for the Mid European viticulture are the varieties 'Heunisch' and 'Roter Veltliner'. Both were used in large dimensions in former times but nowadays are slowly disappearing.

Regarding the parentage of 'Grüner Veltliner' it could be concluded that the maintenance of old and rare varieties is essential. It seems that only a single vine of the grapevine from St. Georgen has survived the centuries without someone taking care for a specific name. Some of the local growers suppose that the historical 'Grünmuskateller' would be the right name for this variety but in reality neither a precise historical description nor any pictures are available. Identification of this variety seems impossible at the moment. As the ampelographic traits are close to 'Grüner Veltliner' it is realistic that the change from 'Grünmuskateller' was not noticed. The problem of this name is also the implication that it should be a Muskat flavoured variety. At the moment no experiences about the taste of the grapes from the vine from St. Georgen are available. The genetic analysis allows also the prediction of Muskat flavour due to the alleles found at VrZag 79 (REGNER et al., 2001). St. Georgen grapevine lacks these Muskat specific alleles.

Another obstacle to these parentages are a not 100 % coincidence of the analysed alleles. First it could be observed that both parents cover one of the alleles from

the offspring but the second did not exist in the parental vines. If there is only one allele length it can be supposed that the second is a null allele and therefore lost for amplification. This is the case for the loci VMC3g8.2 and VMC 3d12 (Table 1) in the 'Grüner Veltliner' heritage and at the loci VMC 1d10, VRZag 26 and VMC 2h10 (Table 3a) for 'Sauvignon'. The true allele length could not be detected and such loci are not helpful to confirm any hypothesis.

Secondly it seems possible that one of the alleles of a locus could not be covered by the parents as it was found at VMC 8g8 for 'Sauvignon' (Table 3a) and for 'Grüner Veltliner' at VVIP17, VMC 2c3 and VMC 1f10 (Table 1a). In such case we only can suppose that mutations have changed the profile during hybridization or later by mutations during the propagation process.

As we have analysed for the parentage of 'Grüner Veltliner' more than 120 and for 'Sauvignon blanc' 105 SSR loci we could find for each chromosome several alleles supporting our hypothesis about parentages. None of the recently published heritages (Bowers and Meredith, 1997) is based on such a high amount of genetic data. In both cases more than 90 % of the investigated loci confirm our theory. We also could observe variability within the varieties. While 'Traminer' shows a higher rate (Regner and Kaserer, 2002) of deviations 'Chenin blanc' and 'Sauvignon' differ only in some rare loci. Age and distribution of a variety is responsible for the degree of variation and that suggests that 'Traminer' is much older than the other varieties (Imazio et al., 2002). Nevertheless 'Traminer' can be confirmed as a key variety for the development of numerous varieties by outcrossing and both 'Grüner Veltliner' and 'Sauvignon' were derived from this source.

Acknowledgements

We are grateful to Mrs. Cornelia Eisenheld for technical support. Some of the analyses used for this study were gained in the frame of EC project Grapegen 06.

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Received November, 17, 2009