Ervi, the intraspecific *Barbera x Croatina* crossbreed: first growing and winemaking experiences in *Lombardia* (north-west of Italy)

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Abstract. *Barbera* and *Croatina* are the two most important grapevine varieties characterizing wines from several districts in North-West of Italy; they coexist on the hilly territories sited south of the Po river (historically known as "*western-cispadana*" area) where they are also blended together to obtain local wines such as *Buttafuoco* and *Rosso Oltrepò Pavese* in Lombardia, and *Gutturnio* in *Emilia Romagna*. *Ervi* is an intraspecific crossbreed between *Barbera* and *Croatina* performed in the '70s and selected over the last decades in order to improve some agronomical traits of both parents. The present study represents the first characterization of development, production and enological performance of the cv. *Ervi* in Lombardia and, more specifically, in the *Oltrepò Pavese* wine district. Long-term results related to a field-based assessment as well as the sensory profiling of wines produced at a micro scale are reported. When compared to *Barbera* and *Croatina, Ervi* shows improved productivity respect to *Croatina* and a better composition as compared to both its parents. Results recommend the introduction of the cv. *Ervi* in Lombardia for the production of high quality red wines.

1 Introduction

The controlled intraspecific hybridization between two cultivars and the following selection among the progeny is a method traditionally used to obtain new grapevine genotypes [1]. Aiming for the selection of new grapevine varieties for traditional red wine production, a breeding program by intraspecific crossing was set up in 1970 by combining cvs. *Barbera* (♀) and *Croatina* (♂) [2,3,4,5]. The selection was performed in the *Piacenza* area leading to the registration of a new cultivar named "*Ervi*" in 1999. In the early 2000s, *Ervi* was planted at the regional experimental station "*Riccagioia*" (*Lombardia* Administrative Region, *Pavia* Province, North-West of Italy) in order to study the adaptability of the new grapevine variety in *Oltrepò Pavese*, the biggest wine-producing area in Lombardia.

Several wine districts from North-West of Italy extend over the hills rising from the southern banks of the Po River to the Apennine Range, including the territories belonging to the provinces (from west to east) of *Cuneo, Asti*, *Alessandria*, *Pavia* and *Piacenza*. A large part of this area shares common origins as well as the most recent history. As a matter of fact, this zone was the northern part of the IX Roman Region (the ancient *Liguria* of the Imperial Rome) and, in the century preceding the Unification of Italy (from 1743, treaty of Worms to 1861), was part of the "*Vecchio Piemonte*" territory. Romans named lands sited on the southern banks of the Po River as *Cispadana* area. The westernmost part of this region can be referred to as "*Cispadana Occidentalis*"; in recent years (2010) [6] the area has become home toan important viticultural development (about 63,000 ha corresponding to almost 10% of the national acreage (Tab. 1 and Fig. 1). *Barbera* and *Croatina* represent the most important red varieties; the former is mostly concentrated in the western area whilst the latter is primarily grown in the easternmost side of the region.

Fig. 1. *Barbera* and *Croatina* are traditionally grown in the hilly areas between the southern banks of the Po River and the Apennine Range; from West to East in the Provinces of *Cuneo*=CN, *Asti*=AT, *Alessandria*=AL, *Pavia*=PV and *Piacenza*=PC.

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Table 1. Comparison between the total area under vines and the *Barbera* and *Croatina* acreage in Italy and in the Western-Cispadana zone. Data 2010 from the 6th General Census of Agriculture [6].

	Total acreage (ha)	*Barbera (ha)*	*Croatina (ha)*
Italy	625,699	20,524	6,120
Cuneo	16,065	2,238	16
Asti	15,559	6,935	67
Alessandria	12,328	4,299	82
Pavia	13,193	2,284	3,851
Piacenza	5,906	1,779	1,690
Western Cispadana	63,051	17,535	5,706

According to the 6th General Census of Agriculture (2010) [6], *Barbera* is grown over 20,524 ha representing the most widespread grapevine variety in the North-West of the country and ranking 6th at national scale; as a matter of fact, partitioning the Italian acreage per cultivar, *Barbera* is only surpassed by *Sangiovese* (71,628 ha), *Montepulciano* (34,824 ha), *Catarratto* (34,794 ha), *Merlot* (28,041 ha) and *Trebbiano toscano* (22,702 ha). Although the planted area is not as extensive as *Barbera*, *Croatina* is grown on approximately 6,100 ha, similar to plantings of other relevant national varieties such as *Nebbiolo*. In the *Pavia* Province and, more specifically in *Oltrepò Pavese* (*Lombardia*), *Croatina* is the main variety at the base of several local wines such as *Bonarda dell'Oltrepò Pavese*, the 8th most produced Italian red wine by volume [7]. When the survey was performed, *Ervi* vineyards were almost non-existent and the first plantings in *Emilia Romagna* Region were in 2008. *Ervi* is currently grown in the *Piacenza* Province where 20 ha are registered (data 2018).

Wines from *Western Cispadana* region produced with *Barbera* and *Croatina* meet two main styles: varietal wines (in which the wine designation corresponds to the cultivar's name) and territorial wines (in which the wine designation corresponds to its geographical origin).

In *Oltrepò Pavese* (Pavia Province, PV, *Lombardia*) and *Colli Piacentini* (Piacenza Province, PC, *Emilia Romagna*), *Barbera* and *Croatina* are blended together also to produce high-quality red wines with Protected Designation of Origin. Depending on grape geographical origin, wines may be designated as *Buttafuoco* or *Rosso Oltrepò Pavese* (*PV*), *Gutturnio Classico* or *Gutturnio* dei Colli Piacentini (*PC*). *Barbera* and *Croatina* are used in comparable proportions in all of these regional wines. If *Gutturnio* can be made only by using these two main cultivars, the *Buttafuoco* also contains other local varieties such as *Ughetta di Canneto* and *Uva rara*.

Ervi was selected in *Piacenza* (*Emilia Romagna*) as part of a program aiming to renovate the local ampelographic platform by selecting new genotypes improving some negative traits of its parents [2]. Among the disadvantageous traits, high acidity level and poor anthocyanin accumulation of *Barbera* grapes, especially when from high vigour zones [8], as well as wine astringency and low basal-bud fruitfulness of *Croatina* [9] still represent the most critical issues of these traditional varieties. *Ervi* shows relatively constant yield and small berries, it ripens earlier than both its parents, and achieves higher soluble solids and total anthocyanin concentration than *Barbera*. The emergent interest on *Ervi* is also due to the optimal basal-bud fruitfulness and low berry detachment force (BDF) at harvest, enhancing its suitability to vineyard mechanization especially as it concerns spur pruning and mechanical harvesting [10].

The research aims to determine if the new crossbreed *Ervi* can represent a resource for the ampelographic platform of *Oltrepò Pavese* (Lombardia) where the *Ervi*'s parents are the most representative varieties for producing red wines (about 6,000 ha, Tab. 1). For the three varieties, plant yield and fruit composition will be assessed. A wine sensory profile of the three varieties will be presented. The results will support the application process required to include *Ervi* into the regional list of grape varieties allowed to be cultivated in Lombardia.

2 Material and methods

The experimental vineyard was planted in 2002 in Oltrepò Pavese wine district at the "Riccagioia" experimental station (*Lombardia* Administrative Region,) sited in *Torrazza Coste* (44°58'40"44 N, 09°5'4"56 E, 150 m asl). *Barbera, Ervi* and *Croatina* grafted onto SO4 rootstock are 1.1 m and 2.5 m spaced within and between the rows, respectively. Vines are long-cane (simple Guyot) pruned and trained to a vertical shoot positioning (VSP) trellis; 12-14 nodes per vine are kept at winter pruning. During the period 2008-2013, 15 vines per cultivar were tagged and the following variables were annually assessed: bud fruitfulness (number of clusters/node), cluster weight (g), total soluble solids (°Brix), titratable acidity (g/L, as tartaric acid equivalents); the grape concentration of anthocyanins and polyphenols was measured in 2011. At harvest, fruit from each cultivar was hand-picked and processed in stainless-steel micro-ferments (two replicates per cultivar with a maximum capacity of 80 L each) according to standard guidelines for red winemaking. Wines were then bottled and sensory analysis was carried out after six month the following spring; the paper reports results only from 2011.

The ampelographic characterisation of the three grapevine varieties was performed in 2011 according to the OIV descriptor list for grape varieties and Vitis species [11].

Field-based data were processed according to the two-way analysis of variance (ANOVA) by considering variety (V) and year (Y) as main sources of variability. In case the F test was significant, mean values were compared by the SNK test (Student Neuman Keuls) at $p \leq 0.05$. Data from sensory analysis were processed according to the Friedman test [12]. Within each descriptor, wine scores were compared by LSD at $p=0.05$.

3 Results

3.1 Ampelographic characterization

The varietal characterization based on leaf and fruit description is reported in table 2. When compared to *Barbera* and *Croatina*, *Ervi* showed shorter vein N1 (code OIV 601) and dissimilar teeth; the cluster was looser as compared to both its parents and smaller than *Barbera*. Single cluster weight generally showed "low values" according to OIV 502 notes; however, a deeper characterisation is reported in table 3. In effect, the OIV 502 considers clusters of about 500g as "medium" because determined as the mean value of the largest cluster of 10 shoots. In addition, the classification proposed by OIV is referred to all the grapevine varieties including wine grapes, table grapes and other Vitis spp. resulting in lower efficacy to discriminate the three cultivars considered as part of the present study.

Table 2. Ampelographic characterization of the three grapevine varieties based on OIV descriptors observed in 2011 at the experimental station "*Riccagioia"* (*Torrazza Coste, Lombardia)*. Codes from OIV065 to OIV84 and OIV601 are referred to mature leaves.

CodeN°	***Barbera***	***Croatina***	***Ervi***
OIV 155 -Shoot: fertility of basal buds (buds 1-3)	medium	very low	medium
OIV 065 – size of blade	medium	medium	medium
OIV 067 – shape of blade	pentagonal	pentagonal and elongated	Pentagonal and short
OIV 068 – number of lobes	five	five and three, cup shape	five
OIV 069 - colour of the upper side of blade	dark green	Medium dark green	medium green
OIV 077 - size of teeth in relation to blade size	large	small	small
OIV 078 – length-width comparison of teeth	medium	alternate short and medium	short
OIV 079 – opening of petiole sinus	closed and overlapped	open	open (little)
OIV 080 – shape of the base of petiole sinus	U shaped	V shaped	V shaped
OIV 084 - *density of hairs on lower side blade*	high	medium	medium
OIV 202 – Bunch length (peduncle excluded)	medium	long	medium
OIV 204 - Bunch: density	dense	medium	loose-medium
OIV 208 – Bunch: shape	cylindrical-conical	conical	conical
Berry size	medium-big (>2.2g)	medium-small (<2.0g)	medium-small (<2.0g)
OIV 223 - Berry shape	Ellipsoid	globose	globose
OIV 601 – length of vein N1	Medium	medium	short

3.2 Yield and fruit composition

Yield per vine significantly differed among the three genotypes (Tab. 3). With highest shoot fruitfulness (1.46) and heaviest clusters (298 g), *Barbera* was the most productive variety with a yield corresponding to 4.4 kg/vine. When compared to *Barbera*, *Ervi* presented similar shoot fruitfulness (1.41 vs 1.46), smaller clusters (218g vs 298 g) and berries (1.65 g vs 2.17 g). Contrariwise, cluster and berry mass were similar to *Croatina*. As a consequence of relationships among the above mentioned yield components, yield per vine in *Ervi* was 3.47 kg -- 37% higher than *Croatina*, and 28% lower than *Barbera*. The TSS concentration in must was lower in *Barbera* (21.8 °Brix) than *Ervi* and *Croatina* which both exceeded the threshold of 24 °Brix. All the varieties were different as a function of titratable acidity. The highest of which being *Barbera* (10.05 g/L), followed by *Ervi* (7.58 g/L) and *Croatina* (5.78 g/L). The must concentration of tartaric and malic acids varied according to variations in titratable acidity and three statistically significant separate groups were identified (Tab. 5).

Table 3. Variation of some yield components as a function of grapevine variety (Data 2008-2013). Mean values and F test, ns = not significant; * and ** = significant per $p \leq 0.05$ and $p \leq 0.01$, respectively. Within each column, values with different letters are significantly different at SNK test ($p<0.05$).

Cvs and sources of variation	Shoot fruitfulness	Cluster weight (g)	Berry weight (g)	Yield (kg/vine)
Croatina	0.79 a	220 a	1.63 a	2.53 a
Ervi	1.41 b	218 a	1.65 a	3.47b
Barbera	1.46 b	298 b	2.17 b	4.44 b
F				
Variety (V)	*20.67* **	*4.64* **	*7.39* **	5.73**
Year (Y)	*3.36* *	*5.81* **	*5.12* **	6.71 **
V x Y	*2.65 ns*	*0.85 ns*	*2.285 ns*	4.39 *

In more detail, *Barbera* presented the highest tartrate and malate concentrations (7.81 vs 3.98 g/L, respectively) followed by *Ervi* (6.88 vs 2.92 g/L), and *Croatina* (5.75 vs 1.99 g/L). Despite the intermediate development of organic acids, *Ervi* showed the highest anthocyanin concentration in grapes (1.79 mg/g) followed by *Croatina* and *Barbera.* *Ervi*'s attitude to accumulate pigments in fruit is also demonstrated when compared to its parents being 60% and 143% higher than *Croatina*

and *Barbera*, respectively. Total phenolics were also significantly higher in *Ervi* and *Croatina* (2.54 mg/g) than *Barbera* (1.05 mg/g).

Table 4. Variation of technological maturity parameters as a function of grapevine variety. (Data 2008-2013). Mean values and F test, ns = not significant; * and ** = significant per p≤0.05 and p≤0.01, respectively. Within each column, values with different letters are significantly different at SNK test (p<0.05).

Cvs and sources of variation	°Brix	Titratable acidity (g/L)	pH
Croatina	24.23 b	5.78 a	3.36 b
Ervi	24.94 b	7.58 b	3.38 b
Barbera	21.80 a	10.05 c	3,05 a
F			
Variety (V)	7.84 **	37.10 **	*60.49* **
Year (Y)	2.44 *	2.97 *	*9.51* **
V x Y	1.47 ns	6.70 **	*14.19* **

Table 5. Variation of tartrate, malate (2008-2013), total anthocyanins (Anth.) and Phenols (2011) concentration as a function of grapevine variety. (Data 2008-2013). Mean values and F test, ns = not significant; * and ** = significant per p≤0.05 and p≤0.01, respectively. Within each column, values with different letters are significantly different at SNK test (p<0.05).

Cvs and sources of variation	Tartrate (g/L)	Malate (g/L)	Anth. (g/L)	Phenols (g/L)
Croatina	5.75 a	1.99 a	1.11b	2.54b
Ervi	6.88 b	2.92 b	1.79c	2.54b
Barbera	7.81 c	3.98 c	0.73a	1.05a
F				
Variety (V)	*28.7***	*5.62**	*20.1***	*13.8***
Year (Y)	*4.07* **	*1,52 ns*	-	-
V x Y	*5.00* **	-		

3.3 Wine sensory analysis

The sensory profile of *Barbera, Croatina and Ervi* wines is showed in table 6. All the varietal wines are described by intense red colour with deep purple hues, fruit smell dominant on spicy and floral notes and very light herbaceous and vegetative hints. However, experimental wines from 2011 when tasted the following spring showed significant differences in some important sensory descriptors such as colour intensity, floral and fruity aromas and taste. More precisely, the colour intensity in *Ervi* wine was similar to *Croatina* and deeper than *Barbera*. Intensity of dark fruit aromas (cherry and blackberry) as well as hints of violet and plum were higher in *Ervi* and *Croatina* as compared to *Barbera* wines. *Ervi* and *Croatina* were similar also in terms of wine taste (higher body and lower acidity respect to *Barbera*) and retro-olfaction perception with longer persistence and higher fruity hints as compared to *Barbera*. However, moderate astringency and distinctive spicy retro-olfaction perception allowed tasters to distinguish *Ervi* from *Croatina*. Furthermore, *Croatina* ranked first regarding the olfaction agreeableness (Fig. 2) whilst both *Ervi* and *Croatina* registered the higher scores as based on global agreeableness (Fig. 3). According to these results, *Ervi* wines show a distinctive aromatic profile that is compatible and complementary with *Barbera* and *Croatina*. As a matter of fact, *Ervi* introduces distinctive taste by smoothing and balancing the main enological issues associated to its parents; more specifically, the astringency related to low-weight flavanols in *Croatina*, and the distinctive acidity in *Barbera*. *Ervi* wines show lower astringency than *Croatina* and moderate acidity when compared to *Barbera*. This set of characteristics allows considering *Ervi* as a possible solution to the oenological improvement of traditional wines produced by blending cvs. *Croatina* and *Barbera* in north-west of Italy.

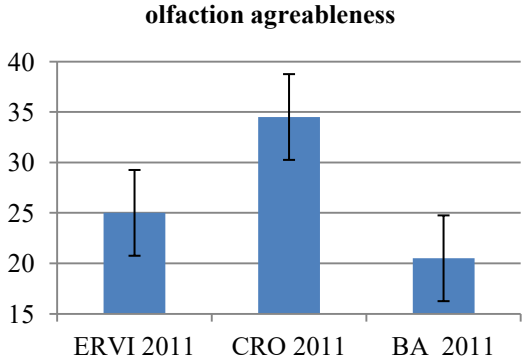

Fig. 2. Olfaction agreeableness of *Barbera* (BA), *Croatina* (CRO) and *Ervi* wines produced in 2011. Wine scores are compared by LSD at p=0.05.

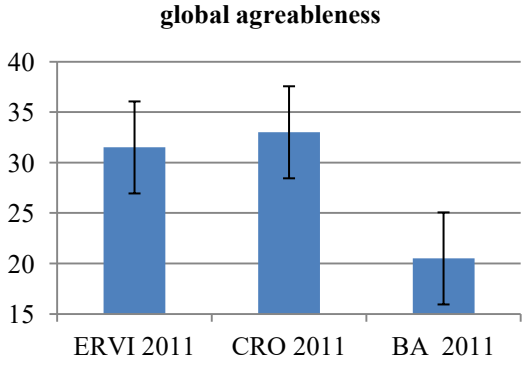

Fig. 3. Global agreeableness of *Barbera* (BA), *Croatina* (CRO) and *Ervi* wines produced in 2011. Wine scores are compared by LSD at p=0.05.

Table 6. Average wines cores for sensory descriptors assessed by the panel test. T= Friedman test, ns = not significant; * and

** = significant per p≤0.05 and p≤0.01, respectively. Within each row, values followed by different letters are significantly different p=0.05. ro = retronasal olfaction.

Descriptors	T	s	Ervi	CRO	BA
Colour intensity	7.773	*	8.88 b	8.25 b	6.50 a
Purple hues	1.996	ns	7.38	7.25	6.50
Smell intensity	0.776	ns	6.50	6.63	6.25
Smell complexity	1.720	ns	6.00	6.38	4.88
Floral	7.362	*	3.62 b	4.00 b	2.25 a
Violet	6.810	*	3.00 b	3.25 b	1.75 a
Rose	1.428	ns	1.75	2.50	1.63
Dried flowers	1.928	ns	1.00	1.25	1.75
Red fruits	10.867	*	4.00 b	4.75 b	2.87 a
Plum	0.241	ns	2.88	3.25	2.88
Cherry	6.501	*	3.62 b	4.62 b	2.87 a
Blackberry	6.918	*	3.37 b	3.12 b	1.75 a
Jammy	1.546	ns	2.63	3.13	3.00
Spicy	0.414	ns	2.63	2.75	2.75
Vanilla	0.344	ns	1.88	1.50	1.50
Cinnamon	2.017	ns	1.00	1.00	1.25
Dried fruit	0.930	ns	1.50	1.50	2.38
Herbaceous or vegetative	1.144	ns	1.88	1.75	1.88
Body	8.188	**	6.75 b	6.87 b	6.25 a
Acidity	2.742	*	5.87 a	5.28 a	6.75 b
Astringency	2.759	*	3.25 a	4.5 b	3.25 a
Bitterness	0.907	ns	2.25	2.50	2.13
Sweetness	0.211	ns	1.75	1.75	1.88
Taste balance	1.870	ns	5.50	5.63	5.50
Persistence	3.802	*	6.37 b	6.25 b	5.62 a
Floral (ro)	1.786	ns	2.88	2.75	2.88
Fruity (ro)	5.307	*	4.25 b	4.00ab	3.12 b
Spicy (ro)	3.887	*	3.37 b	2.75 a	2.25 a
Vegetative (ro)	1.440	ns	1.75	1.25	1.25

4 Conclusions

The current experiment has confirmed some negative traits affecting *Croatina*'s yield components as well as *Barbera*'s fruit and wine composition. In effect, depending on bud-fertility, the number of clusters per vine is very low in *Croatina* (especially when referring to basal nodes), while the must acidity of *Barbera* is frequently too high even in case of optimal ripening and very high sugar concentration. The main clones tested in *Lombardia* [13] that are currently available for establishing new vineyards show the same issues and do not seem a solution for improving vine productivity and wine quality. For these reasons, in order to maintain the productivity and to preserve the typical style of most traditional territorial wines, the new crossbreed *Ervi* (*Barbera* x *Croatina*) was tested for the first time in *Lombardia* (*Oltrepò Pavese* wine district).

Results collected over a 6-year period show that agronomical and enological performance of *Ervi* are most frequently better than parental varieties; its bud fertility (1.41 clusters/vine) was significantly higher than *Croatina* (0.79) and similar to *Barbera* (1.46); the titratable acidity of *Ervi* (7.58 g/L, tartaric acid equivalent) was lower than *Barbera* (10.05 g/L), and higher than *Croatina* (5.78 g/L). In addition, *Ervi* shows a more balanced acid profile, with lower malate than *Barbera*. In conclusion, *Ervi* is a good candidate to foster innovation of the ampelographic platform in *Lombardia*.

References

1. A. Vercesi, Phytomag. **II**/4, 21-29 (2009).
2. M. Zamboni, M. Fregoni, Acta Hortic. **528**, 689-692 (2000).
3. M. Gatti, R. Miravalle, M. Zamboni, Inf. Agr. 31, 54-57 (2009).
4. M. Fregoni, M. Zamboni, A. Vercesi, A Perino, Proceeding 4° Symposium on the Viticulture of Oltrepò Pavese, 17-29 (1992).
5. M. Fregoni, M. Zamboni, R. Colla, *Caratterizzazione ampelografica dei vitigni autoctoni piacentini* (Grafiche Lama Piacenza, 2002).
6. www4.istat.it/it/censimento-agricoltura/agricoltura-2010
7. www.federdoc.com
8. M. Gatti, A. Garavani, A. Vercesi, S. Poni, Aust J Grape Wine Res, **23** (3), 399-408 (2017).
9. A.Calò, A. Scienza, A. Costacurta, *Vitigni d'Italia* (Edagricole, 2006).
10. M. Gatti, M. Zamboni, M.C. Merli, S. Civardi, S.Poni, Acta Hort. **978**, 229-236 (2013).
11. O.I.V., 2007. *Descriptor list for grape varieties and Vitis species*. Second Edition.
12. R.J. Freund, W.J. Wilson Metodi Statistici (Piccin 2001).
13. A. Vercesi, Inf. Agr.-Speciale : Selezione genetica e sanitaria della vite, **11**, 9-13 (2010).