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Evaluation of teinturier type grape (*Vitis vinifera*) germplasms for wine purpose

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Abstract

The teinturier type grapes (*Vitis vinifera* L.) produce deep coloured wines having bold flavours and distinctive characteristics. Ten teinturier type grapes were evaluated for bunch and berry parameters. Some quality parameters of prepared wines were also assessed. A wide range of variability was observed in days required for full bloom, days from fruit setting to harvesting and growing degree days. There were significant variations in bunch and berry parameters in all genotypes during both the years. Pusa Navrang produced smallest bunches, while Aliquant Bauschet had the longest. The hybrid, Pusa Navrang × Chardonnay, produced boldest berries and maximum bunch weight. Significant differences were also observed in biochemical parameters like total soluble solids (TSS), acidity, phenolic acids, tannins, and anthocyanins. Wines prepared from these grape types also showed significant differences. Wines made from ARI-239 had the highest ethanol levels. The varietal differences influenced the composition and antioxidant potential of wines. Vintage effects were also observed. Based on bunch and berry parameters and wine quality, Manjari Medika, Pusa Navrang, Pusa Navrang × Red Globe, ARI (H-27) and Rubired were found promising.

Key words: Vitis, Bunch Parameters, Berry, Anthocyanins, Ethanol

Grapes (*Vitis vinifera* L.) are considered most important popular commercial fruit globally. It is commercially grown in temperate to tropical conditions in various countries. As per OIV, the grapevines covered an area of 7.2 million ha and production was 74.7 million tons during 2023. It was also recorded that almost 50% of total produce (34.0 million tonnes) was pressed for wine and juice purpose (OIV, 2023). Global wine production was 237 million hectolitre and major wine producers were France, Italy, Spain, USA and Chile (OIV, 2024). Globally about 10,000 grapevine varieties are known. Of them, 13 cover more than one-third of the world's vineyard area, while 33 varieties cover 50% area (OIV 2017). Among wine grape varieties, Cabernet Sauvignon has covered maximum area followed by Merlot and Tempranillo. The selection of wine grape variety is crucial as it directly influences organoleptic characteristics of wine such as colour, aroma and structure. In India, Cabernet Sauvignon, Shiraz, Merlot, Malbec, Zinfandel are mainly red wine grape varieties are grown while Sauvignon Blanc, Chenin Blanc, Chardonnay, Riesling, etc. varieties are grown for white wine-making (Sharma *et al.* 2020).

In grape berries, anthocyanins are synthesized in the skin, not in the pulp. In contrast, in the 'Teinturier type grapevine varieties are deviate from this natural phenomenon by accumulating variable levels of anthocyanins in berry flesh/juice also (Röckel *et al.* 2020). The teinturier varieties have been utilized for blending purpose to increase the colour of pale red wines and remain economically important worldwide (Anderson and Aryal 2015). Anthocyanin content in these varieties varied at large and anthocyanin profile study revealed that not all 21 anthocyanins were recorded in teinturier type varieties (Kőrösi *et al.* 2022). Anthocyanin synthesis begins in the flesh and later extends to the skin. Tian *et al.* (2021) reported that teinturier cultivars contain significantly higher total anthocyanin content than non-teinturier grape varieties. Teinturier grapes have elevated flavonoid concentrations and frequently utilized to improve/modify the colour of red wines, elevate tannin levels and increase ageing potential (Chen *et al.*, 2018). Revilla *et al.* (2016) mentioned that several teinturier type varieties, including Alicante Bouschet, are commonly utilized to blend for creation of wines with dark colour from lighter-coloured grape varieties. Enchantment can be used to produce high-quality, deeply red-coloured wines as well as blending purpose also (Mayfield *et al.* 2021). A few Few teinturier type genetic material has been breed in India and mostly studied for juice purpose. But no systematic study is conducted on evaluation of these available teinturier grape genotypes for wine purpose. Considering the importance of teinturier type grapes in winemaking, present study was conducted to compare these genetic materials for grape and wine quality parameters.

MATERIALS AND METHODS

The experiment was conducted at ICAR-National Research Centre for Grapes, Pune, during seasons of

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2022-23 and 2023-24. A total of ten Teinturier type accessions available in the National Active Germplasm Site for Grapes were utilized under this study. The research farm is situated in mid-western Maharashtra (latitude 18°92'32"N and longitude 73°.59'13"E) having elevation of 560 m. The vines were trained to extended Y trellis system of spaced at 2.74 m between rows and 1.21 m between vines. Four vines of each accession were earmarked, and data were recorded.

Growing degree days (GDDs) were calculated for each day based on the daily recorded maximum (Tmax) and minimum (Tmin) temperature. For calculating GDD, 10 °C was used as base temperature (Tbase). GDD under this experiment was calculated from fruit setting to harvesting.

$$GDD = (Tmax + Tmin) / 2 - Tbase$$

Bunch length and bunch weight were calculated as average of 10 bunches. Berry related parameters, *viz.* diameter, length and skin thickness were estimated by using 20 berries collected from different parts of bunches. Skin thickness was estimated by using micrometer. Juice extracted from 20 berries of each was utilized for recording the related parameters like TSS, acidity, phenols, tannins and anthocyanins content. Total phenolic acids were quantified by following the procedure of Singleton and Rossi (1965) against gallic acid. Absorbance was recorded at 765 nm using UV-spectrophotometer. Content of anthocyanins in samples was noted by following method of Fuleki and Francis (1968). Tannin contents in wines were estimated by Folin Denismethod suggested by Singleton and Rossi (1965) where tannic acid was utilized as standard.

Wines were prepared according to methodology suggested by Sharma *et al.* (2018). A SO_2 level of 80 ppm was maintained in wines. Prepared wines were stored at 10 °C and two rackings (30 days duration of each) were performed. Wines stored at 10 °C were utilized for further studies. OenoFoss (FTIR-based wine analyser) was utilized for estimation of wine parameters. The generated data were statistically analysed according to CRD by adopting OPSTAT software.

RESULTS AND DISCUSSION

There were variations in phenological stages of plant types studied. The duration of pruning to full bloom varied 35-41 days during 2023, while it was 36-42 days during 2024 (Table 1). During 2024, days from pruning to full bloom were more. The flowering period varied from 4-8 days during 2023, while it was 5-7 in 2024. Days recorded from fruit setting to harvesting ranged 83-114 and 82-115 during 2023 and 2024, respectively. Growing degree days (GDD) recorded after fruit setting ranged 1109.62-1476.94 and 1176.44-1616.83 during 2023 and 2024, respectively. Occurrence of phenological stages in grapevines is genetically determined feature which is highly variable from one to other variety. Somkuwar *et al.* (2024) also recorded variability among wine grape varieties in regards days required for harvesting.

The phenological stage variation and GDD accumulation up to harvesting affected grape types also (Kamila *et al.* 2024). The genotypes express variability for required GDD across the seasons (Bondade and Deshpande 2021). Different *V. vinifera* genotypes exhibit significant variability between phenological stages. Our findings are in same pattern and variability was recorded among the genotypes of same species, i.e. vinifera. However, prevailing temperature and photoperiod under conditions of region have impact on phenological development of grapevines (Jones 2003). Even vintage variations in weather also affect days required for occurrence of phenological stage. Such variations were recorded in our study also.

Significant variations in bunch and berry quality parameters were recorded in Teinturier type grapes (Table 2). Pusa Navrang recorded with smallest bunch (bunch length 10.5 and 10.2 cm in 2023 and 2024, respectively). While maximum bunch length with 18.9 cm in 2023 and 18.4 in 2024 was recorded in Aliquant Bauschet (Table 2). Accession, Pusa Navrang × Chardonnay, produced bold berries in terms of maximum length and diameter during both the years. Maximum bunch weight was also recorded in same and berry diameter while minimum values for these parameters were registered in ARI-239. Pusa Navrang registered minimum diameter and E26/5 IIHR Hybrid was also at almost same level. Berries of Aliquant Bauschet had thinnest skin, while Manjari Medika berries contained thick skin. Significant differences were observed among the grape types for recorded parameters during both years.

During 2023, TSS ranged 18.2 in A48-1 (Pusa Navrang × Chardonnay) to 22.5 °B in E26/5 IIHR Hybrid. While, minimum TSS (20.4 °B) estimated in Pusa Navrang and ARI (H-27) during 2024 (Table 3). The E26/5 IIHR Hybrid recorded maximum TSS content during both years. More TSS accumulation was observed during 2024. Acidity contents in accessions were suitable for wine making in both harvests. Berries of Pusa Navrang contained minimum acidity (0.50 g/L) in harvest of both years, while berries of Pusa Navrang × Red Globe recorded with maximum acid content. Sugar in berries is considered important for juice making while combination of sugar, anthocyanin and acidity levels are important for wine purpose (Somkuwar and Naik, 2024).

Antioxidant activities of grape juices were recorded

Table 1. Days required for phenological stages and GDD

Variety	Pruning to full bloom (days)		Flowering period (days)		Fruit setting to harvesting (days)		GDD (after fruit setting)	
	2023	2024	2023	2024	2023	2024	2023	2024
E26/5 IIHR Hybrid	38	40	7	6	96	95	1304.25	1360.70
ARI (H-27)	38	39	4	5	111	109	1463.45	1573.31
Pusa Navrang × Red Globe	41	42	8	7	83	82	1198.41	1176.44
Manjari Medika	40	40	7	6	91	92	1257.85	1290.83
Pusa Navrang × Chardonnay	34	36	7	6	89	90	1198.43	1261.48
Aliquant Bauschet	38	39	7	7	111	110	1476.90	1573.31
A48-1 (Pusa Navrang × Chardonnay)	37	38	8	7	85	86	1109.62	1204.79
Pusa Navrang	38	40	4	5	94	92	1154.46	1332.35
Rubired	38	38	6	6	114	115	1476.94	1616.83
ARI-239	35	36	6	5	100	98	1320.85	1417.42

Table 2. Bunch berry quality parameters

Variety	Bunch length (cm)		Bunch weight (g)		Berry diameter (mm)		Berry length (mm)		Skin thickness (mm)	
	2023	2024	2023	2024	2023	2024	2023	2024	2023	2023
E26/5 IIHR Hybrid	13.2	13.0	220	216	12.3	12.2	13.6	13.9	0.19	0.18
ARI (H-27)	15.4	15.1	250	247	12.5	12.6	14.5	14.7	0.22	0.22
Pusa Navrang × Red Globe	16.3	15.9	165	168	14.8	14.8	16.0	16.4	0.23	0.24
Manjari Medika	15.9	15.8	230	236	16.2	16.0	16.5	16.7	0.25	0.25
Pusa Navrang × Chardonnay	11.0	11.2	320	318	18.2	18.4	23.1	22.8	0.23	0.23
Aliquant Bauschet	18.9	18.4	265	261	15.6	15.7	20.1	19.9	0.15	0.16
A48-1 (Pusa Navrang × Chardonnay)	16.5	16.1	260	268	16.2	16.4	19.4	19.1	0.19	0.20
Pusa Navrang	10.5	10.2	254	253	12.4	12.1	13.7	13.3	0.25	0.25
Rubired	13.6	13.3	290	292	12.8	13.1	14.9	15.1	0.16	0.17
ARI-239	12.2	11.8	56	61	12.4	12.1	13.3	13.2	0.21	0.20
S.E (m)±	0.113	0.13	2.296	2.60	0.111	0.14	0.145	0.17	0.002	0.002
CD @ 5%	0.324	0.40	6.612	7.72	0.320	0.41	0.417	0.51	0.005	0.007

Table 3. Biochemical variations among teinturier type grapes

Variety	TSS (°B)		Acidity (%)		Phenol (mg GAE/g)		Tannin (mg TAE/g)		Anthocyanin (mg/L)	
	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024
E26/5 IIHR Hybrid	22.5	22.7	0.61	0.60	3.57	4.58	1.04	1.04	786.12	797.89
ARI (H-27)	19.2	20.4	0.55	0.52	3.45	3.86	1.15	1.13	795.75	807.31
Pusa Navrang × Red Globe	20.0	21.8	0.65	0.61	2.85	3.24	0.91	0.94	855.45	873.84
Manjari Medika	22.1	22.4	0.52	0.52	5.14	6.24	2.19	2.34	754.92	776.32
Pusa Navrang × Chardonnay	20.4	21.8	0.60	0.57	2.83	2.13	1.14	1.63	742.59	783.89
Aliquant Bauschet	20.6	21.6	0.54	0.55	4.75	5.21	1.26	1.61	597.00	608.16
A48-1 (Pusa Navrang × Chardonnay)	18.2	20.8	0.51	0.51	3.36	4.11	1.49	1.84	913.61	792.67
Pusa Navrang	20.2	20.4	0.50	0.50	5.13	5.86	1.67	1.98	749.92	773.94
Rubired	19.5	21.5	0.58	0.60	2.29	2.93	1.67	1.83	729.50	713.53
ARI-239	20.5	21.7	0.59	0.57	3.61	3.91	1.02	1.43	625.89	646.27
S.E (m)±	0.134	0.18	0.046	0.005	0.587	0.05	0.078	0.02	7.71	7.23
CD @ 5%	0.386	0.54	0.133	0.015	1.744	0.14	0.232	0.04	22.92	21.48

Table 4. Variability in wine parameters

Variety	Sugar (g/L)		Acidity (g/L)		pH		Ethanol (%)	
	2023	2024	2023	2024	2023	2024	2023	2024
E26/5 IIHR Hybrid	0.0	0.16	5.30	4.13	3.56	3.14	11.13	10.13
ARI (H-27)	2.53	2.57	4.56	4.14	3.24	3.77	10.13	10.30
Pusa Navrang × Red Globe	1.93	1.03	5.80	6.04	3.72	3.34	10.86	10.50
Manjari Medika	0.63	0.00	4.43	3.81	3.12	3.86	10.74	11.64
Pusa Navrang × Chardonnay	2.36	0.00	5.13	5.02	3.46	3.57	10.83	10.16
Aliquant Bauschet	1.43	0.00	4.60	5.47	3.23	3.59	10.13	10.51
A48-1 (Pusa Navrang × Chardonnay)	0.76	0.00	3.80	5.05	3.05	4.00	10.73	10.40
Pusa Navrang	1.26	0.00	4.60	5.49	3.14	3.64	10.26	11.46
Rubired	1.80	0.63	4.83	4.47	3.35	4.15	10.23	10.10
ARI-239	0.46	0.00	5.16	5.20	3.61	3.90	11.26	11.86
S.E (m)±	0.08	0.08	0.05	0.04	0.01	0.02	0.04	0.21
CD @ 5%	0.14	0.24	0.15	0.11	0.036	0.05	0.125	0.62

in the form of phenolic acid, tannins and anthocyanins. Significant differences were observed among teinturier type grapes for these antioxidant activities during both years (Table 3). The content of phenolic acids in grape juices were measured against gallic acid. Maximum phenolic content 5.14 and 6.24 mg GAE/g was estimated in Manjari Medika berries from 2023 and 2024 harvest years, respectively. While berries of Pusa Navrang × Chardonnay contained minimum phenolic acids in both years. Juice collected from Manjari Medika grapes contained maximum tannins in both years, while juice obtained from Pusa Navrang × Red Globe was registered minimum tannins. Anthocyanins content ranged 597.00-913.61 mg/L in 2023, while this was 608.16-873.84 mg/L in 2024. In 2023, maximum anthocyanins content was recorded in A48-1 (Pusa Navrang × Chardonnay), while it was maximum in Pusa Navrang × Red Globe in 2024.

Genotypic diversity and growing conditions affect biochemical attributes in grapes (Naik *et al.*, 2023). The content of TSS, acidity, tannins, phenols and anthocyanins were affected by grape types in our study. Kunter *et al.* (2024) highlighted the substantial impact of grape varieties on berry composition in sugar and acidity content. The red-fleshed grapes contain much higher contents of total phenolic compounds and anthocyanins (Lu *et al.* 2023). Wide variations in the content of anthocyanins and phenolic compounds across different types of grapes were recorded by Liang *et al.* (2011). Kőrösi *et al.* (2022) also recorded wide level of variability in anthocyanins content among teinturier type grapes.

In present study, variation in anthocyanins content were also recorded. Juice and skins of teinturier grapes contain high degree of tannins. A good tannin contents was estimated in grapes of present study. The variations in contents of phenols, anthocyanins and tannins among grape types was due to genetic makeup as well as expression under growing conditions of the region. Vintage effect was also expressed in variation of biochemical contents in studied grape types. The conditions existing in the individual vintages have influence on degree of ripeness, anthocyanins and colour capacity in grapes. (Balik and Kumsta 2008). While, Minnaar *et a*l. (2022) recorded vintage effect was recorded for specific individual phenolics in the harvested grapes. It was concluded that vintage has a limited effect on phenolics. However, data from present study clearly showed vintage effect in phenolic acids content of teinturier type grapes.

During 2023, acidity ranged between 3.80-5.80 g/L, while in 2024 it was 3.81-6.04 g/L (Table 4). Wine made form Pusa Navrang × Red Globe resulted in maximum acidity content in both years (Table 4). Wines prepared from Pusa Navrang × Red Globe, Aliquant Bauschet, A48-1 (Pusa Navrang × Chardonnay), Pusa Navrang and ARI-239, during 2024 were gave more acidity than wines of 2023. But pH of the wines was not in same manner. Across both the year, pH value of wines prepared from A48-1 (Pusa Navrang × Chardonnay) registered a maximum pH of 4.0. Higher pH values showed lower microbial stability. The ethanol content in wines is related to TSS or sugar content in the must.

Wines prepared from ARI-239 were recorded with maximum ethanol in both the years. However, differences among grape types were significant in both the years. Mayfield *et al.* (2021) found Enchantment (a teinturier winegrape) as a suitable for producing varietal or blending purpose. Somkuwar *et al.* (2024) recorded variations in wine quality parameters when evaluated red wine grapes under Pune conditions. Wine parameters varied with genotype, growing conditions, berry traits, winemaking practices, and vintage, as climatic variability markedly influenced quality and aging potential.

CONCLUSION

The Teinturier type grape varieties are widely utilized for blending and improving the colour of wines. The wines prepared from Teinturier type grapes were rich in anthocyanins and phenolics, and these compounds were related to antioxidant properties. Hence, the wines made from teinturier type grapes have potential for health-conscious consumers.

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