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Improvement in quality of wine by blending white and coloured grapes

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ABSTRACT

Blending of juices from four white grape varieties viz., Thompson Seedless, Chenin Blanc, Sauvignon Blanc and Italia with three coloured varieties, viz., Shiraz, Ruby Red and Bangalore Blue, was done in 2:1 and 3:1 ratios to assess the effect of blending on wine quality. White varieties blended with Bangalore Blue recorded maximum titratable acidity (1.23%), while those blended with Ruby Red showed the least acidity (0.42%), Alcohol content in the wine ranged from 8.11% (Italia + Ruby Red, 2:1) to 12.04% (Chenin Blanc + Shiraz, 2:1). The range of values for tannin content (0.007% to 0.044 %) and total phenol content (228mg/l to 571mg/l) indicated that white varieties blended with the coloured cv. Shiraz had the lowest content of tannins and total phenols in wine, while, those blended with cv. Ruby Red showed highest content of these in the blended wines. Hence, among different blends, Chenin Blanc, Thompson Seedless, Sauvignon Blanc and Italia blended with the coloured variety Shiraz, in 2:1 ratio, produced good quality wine.

Key words: Grape, coloured varieties, white varieties, wine, blending

INTRODUCTION

Blending of wines (coupage, assemblage) is frequently used to equilibriate composition of wines and to increase their stability, colour and quality. Therefore, it is of great interest to wineries to work out optimum proportions of each component in the blend to achieve perfect quality of the wine. Nowadays, there is an increasing interest in studying grape varieties that could yield better blends and coupages, with originalquality-attributes. Another objective of blending wines is to optimize use of certain grape varieties to cut production costs (Escudero-Gilete *et al*, 2010)

Most studies in literature on wine blending are based on sensorial attributes (Datta and Nakai, 1992; Monagas *et al*, 2006; Monagas *et al*, 2007). Blending wines is a complex process demanding great rigour. Analytical and colorimetric study of original wines and their mixtures may lead to a better knowledge of the influence of the particular phenolic composition of the grape on wine characteristics especially colour (Escudero-Gilete *et al*, 2010). Polyphenolic compounds are also important sensory components providing colour, taste, bitterness, astringency and microbiological stability (Xi Zhu-mei *et al*, 2010)

Coloured and white grapes are used for preparing blended grape juice and wine. Akopyan (1979) reported that quality of red wines could be improved by blending thereby resulting in reduction of acidity and tannin content. According to Pawar (2002), wine from blended juice of 'Ugni Blanc' and 'Sharad Seedless' at 1:3 ratio gave better quality of wine over the other blends. Suitability of a grape variety for the purpose is judged by certain criteria which differ from case to case. Wine prepared from white varieties is dull-coloured. Hence, to overcome this, blending is a method to impart colour, flavour and acceptability. With this objective, wines were prepared by blending juices of white grape varieties (Sauvignon Blanc, Chenin Blanc, Thompson Seedless and Italia) with coloured varieties (Shiraz, Ruby Red and Bangalore Blue) in two different proportions, i.e., 2:1 and 3:1 ratios. The study involves analysis of various biochemical properties and organoleptic evaluation of different wine blends.

MATERIAL AND METHODS

Wine was prepared by blending juices of four white grape varieties (Thompson Seedless, Chenin Blanc, Sauvignon Blanc and Italia) with three coloured varieties

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(Shiraz, Ruby Red and Bangalore Blue) in two proportions (2:1 & 3:1). Treatments were replicated thrice. Total number of treatments was twenty four.

T_1- Thompson Seedless + Shiraz (2:1)

T_2- Thompson Seedless + Shiraz (3:1)

T_3 - Thompson Seedless + Ruby Red (2:1)

T_4 - Thompson Seedless + Ruby Red (3:1)

T_5- Thompson Seedless + Bangalore Blue (2:1)

T_6- Thompson Seedless + Bangalore Blue (3:1)

T_7 - Chenin Blanc + Shiraz (2:1)

T_{8-} Chenin Blanc + Shiraz (3:1)

T_9- Chenin Blanc + Ruby Red (2:1)

T_{10-} Chenin Blanc + Ruby Red (3:1)

T_{11} - Chenin Blanc + Bangalore Blue (2:1)

T_{12-} Chenin Blanc + Bangalore Blue (3:1)

T_{13} - Sauvignon Blanc + Shiraz (2:1)

T_{14} - Sauvignon Blanc + Shiraz (3:1)

T_{15}- Sauvignon Blanc + Ruby Red (2:1)

T_{16}- Sauvignon Blanc + Ruby Red (3:1)

T_{17} - Sauvignon Blanc + Bangalore Blue (2:1)

T_{18} - Sauvignon Blanc + Bangalore Blue (3:1)

T_{19} - Italia + Shiraz (2:1)

T_{20} - Italia + Shiraz (3:1)

T_{21} - Italia + Ruby Red (2:1)

T_{22} - Italia + Ruby Red (3:1)

T_{23} - Italia + Bangalore Blue (2:1)

T_{24} - Italia + Bangalore Blue (3:1).

Wine samples were analyzed for titrable acidity, alcohol content, tannins, total phenols, and, organoleptic evaluation, viz., appearance, aroma, flavour, taste, colour and overall acceptability of the wine.

Wine preparation

The following procedure, as outlined by Joshi (1995) was followed for reparation of the wine.

a. Preparation of yeast culture

Yeast strain *Saccharomyces cerevisiae* var *ellipsoideus* was used in the present study. Fresh grape juice was diluted in the ratio 1:1 (one litre juice with one litre distilled water) and was pasteurized. A little quantity of the pasteurized juice from the container was poured into a test tube containing the yeast culture, under aseptic condition, and mixed. The culture was ready for inoculation after 24h when plenty of bubbling was observed.

b. Preparation of 'Must'

The berries were washed with water and hand-crushed, then filtered through a cheese cloth. The clear juice thus obtained was used for fermentation. TSS and pH were estimated and adjusted to 24^0B and 3.5 respectively. Potassium meta-bisulphite was added to the juice @ 100-150mg per litre to inhibit growth of wild yeast and other microorganisms causing spoilage, and also to prevent browning due to oxidation. This was treated as 'Must'.

c. Fermentation

Must extracted after SO_2 treatment was inoculated with 2% (v/v) yeast culture and left at 20+1°C for primary fermentation. Nearly 7 days were needed to complete the primary fermentation process for red wine, and 10 days for white wine. Fermentation was completed when no more bubbles were released. This was also ascertained by stabilizating TSS for two successive days. TSS is normally to 7 or 8°Brix.

d. Filtration

After completion of fermentation, the supernatant was siphoned off, filtered through a muslin cloth, and placed for cold stabilization for a week.

e. Clarification

After filtration, if the wine was found not clear, it was clarified using clarifying agents such as Bentonite (150ppm) to recover wine of crystal-clear finish.

f. Siphoning/ Racking

Siphoning of clear liquid from the fermented must was done four times at fortnight intervals to get a clear liquid.

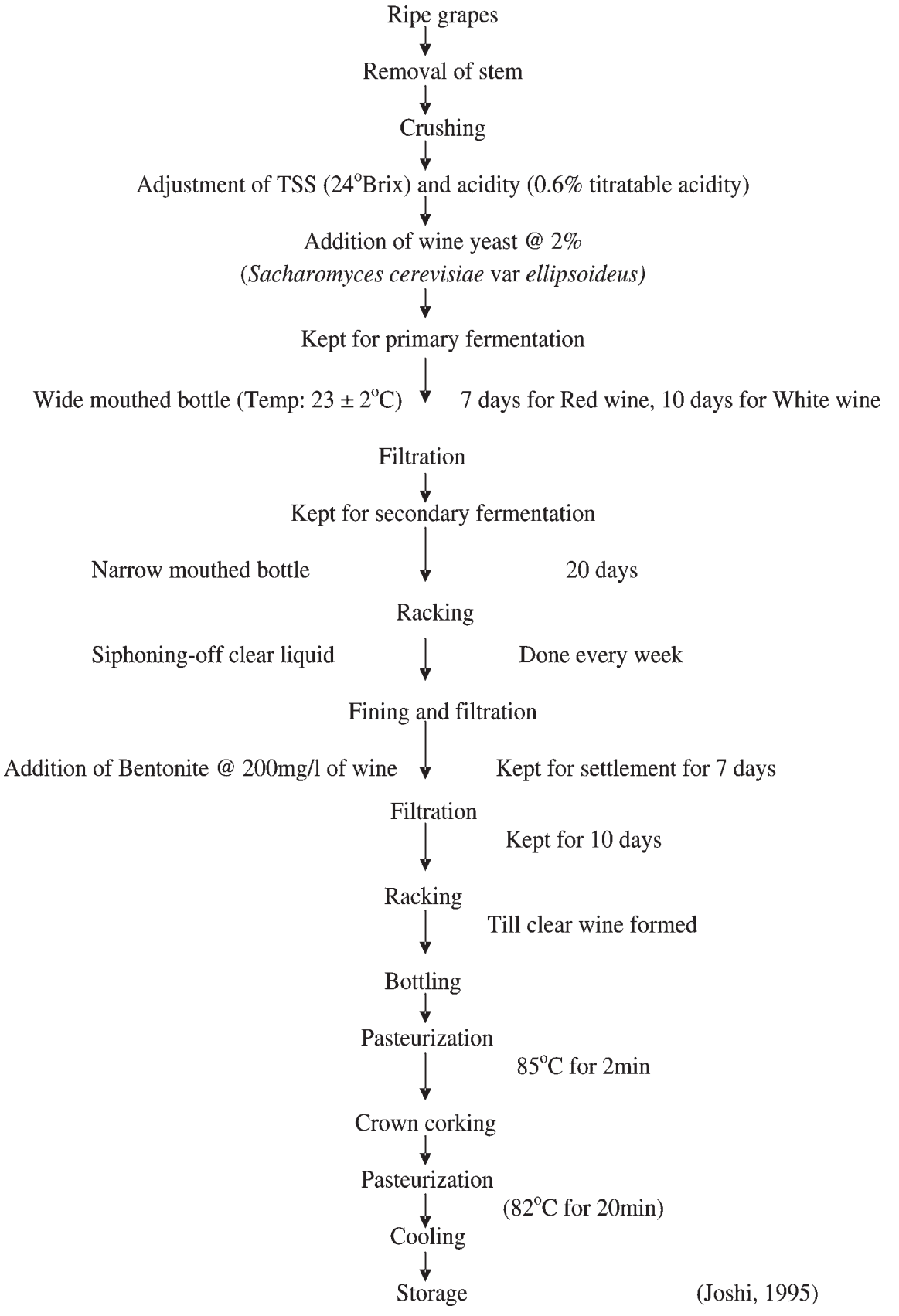
g. Pasteurization

After clarification, the clear wine was siphoned off and transferred to fresh sterile bottles, corked and subjected to pasteurization at 82^0C for 20 minutes.

h. Maturation

After cooling, the bottles were stored for maturation in a BOD incubator at 10°C for 90 days. During maturation, the wine was racked regularly.

Flow chart for preparation of grape wine



(Joshi, 1995)

Biochemical analysis

a. Estimation of titratable acidity

Titratable acidity of wine was determined by AOAC method (1965) using 0.1N NaOH and expressed as % tartaric acid.

$$\text{Tartaric acid (g) /100 ml wine} = \frac{\text{ml NaOH x Normality of NaOH x 0.075 x 100}}{\text{Volume of sample (ml)}}$$

b. Estimation of alcohol

Alcohol content of wine was estimated using a spectrophotometer at 600nm as (Natu *et al,* 1986) using sulphuric acid and potassium dichromate, and was expressed as % alcohol content.

c. Estimation of tannins

Tannins in wine were determined by the method of Amerine and Joslyn (1951) using indigo carmine as the dye and titrated against potassium permanganate solution (0.1N).

$$\% \text{ Tannins} = C \times \text{Normality of } KMnO_4 \times 0.0416 \times 100/\text{Volume of wine (ml)}$$

d. Estimation of total phenols

Total phenol content in the wine was estimated by the procedure of Sadasivam and Manickam (1996). Phenols react with phosphomolybdic acid in Folin-ciocalteau reagent in an alkaline medium and produce a blue-coloured complex (molybdenum blue) measured at 650nm in a spectrophotometer, and is expressed as mg/ml of wine.

Organoleptic evaluation

Sensory evaluation of wine was done for appearance, aroma, flavour, taste, colour and overall acceptability after maturation of the wine. A panel of 10 members evaluated wine samples on a 20 point scale. Wine samples were graded on a hedonic scale (Table 1).

All parameters were recorded for two consecutive years. The data was pooled and means were calculated for both the years. Statistical analysis was applied as per Panse and Sukhatme (1967).

Table 1. Hedonic scale used in the study

Quality	Hedonic scale	20 point scale score
Excellent	7	18-20
Good	6	15-17
Fair	5	12-14
Ordinary	4	9-11
Poor	3	6-8
Bad	2	3-5
Very bad	1	1-2

Table 2. Quality parameters of wine from grapes

Biochemical properties of wine	Standard International Wine composition (A)	Wine quality in different blends studied (B)
Titratable acidity	0.40 - 1.5%	0.42 - 1.23%
Alcohol	7.4 -15.5%	8.11 - 12.04%
Tannins	0.002 - 1.40% (White wine) 0.04 - 3.26% (Red wine)	0.007 - 0.044%
Total phenols	246-426 mg/l (White wine) 910- 2160 mg/l (Red wine)	283 - 570mg/l

A - Adil *et al*,1980; Bhalerao, 2001; Suresh *et al*, 1985; Pawar, 2002
B - Results of the present study

RESULTS AND DISCUSSION

Mean data for two years on biochemical properties of wine are presented.

Titratable acidity

Grape juice and wine mainly contain organic acids like tartaric, malic and citric acid. These play an important role in quality of a wine, particularly tartness, colour and keeping-quality. Data on titratable acidity of wine with various treatments are presented in Table 3.

Significant variation was observed among different blending treatments and time (years). However, interaction between treatments and years showed no significant effect.

Pooled data indicate that T_{12} [Chenin Blanc + Bangalore Blue, (3:1)] recorded maximum titratable acidity (1.23%), followed by T_{23}, T_{24}, T_{11}, T_{18}, T_{17}, T_{20}, T_8 and T_{19}, which were at par. Minimum titratable acidity (0.42%) was recorded in T_3 (Thompson Seedless + Ruby Red, 2:1), followed by T_9, T_{10}, T_4 and T_1. Rest of the treatments recorded intermediate values, ranging from 0.66 to 1.01%.

It was observed that white varieties blended with Bangalore Blue recorded maximum titratable acidity while those blended with Ruby Red showed the lowest acidity. The blends under the study yielded optimum values (Standard International Wine Composition values, 0.40 to 1.5%) for titratable acidity. Acidity imparts flavor too to the wine and is a crucial factor in wine making (Ethiraj and Suresh, 1978). Dry table-wines require high acidity (0.6 to 0.9%), while sweet (dessert) wines require 0.5 to 0.6% acidity (Bammi, 1968).

Alcohol content

In the present study, alcohol content in blended wines ranged from 8.11 to 12.04% (Table 3). Wines blended with

Table 3. Evaluation of various wine blends for titratable acidity and alcohol content

Treatment details		Titratable acidity of wine (%)			Alcohol content of wine (°B)		
		Batch I	Batch II	Mean	Batch I	Batch II	Mean
T_1	Thompson Seedless + Shiraz 2:1	0.55	0.62	0.58	11.59	11.44	11.51
T_2	Thompson Seedless + Shiraz 3:1	0.61	0.72	0.66	10.72	10.38	10.55
T_3	Thompson Seedless + Ruby Red 2:1	0.42	0.43	0.42	8.40	8.28	8.34
T_4	Thompson Seedless + Ruby Red 3:1	0.46	0.49	0.47	8.83	8.54	8.68
T_5	Thompson Seedless + B. Blue 2:1	0.66	0.68	0.67	9.24	9.15	9.19
T_6	Thompson Seedless + B. Blue 3:1	0.75	0.88	0.81	9.83	9.73	9.78
T_7	Chenin Blanc + Shiraz 2:1	0.92	1.01	0.96	12.11	11.97	12.04
T_8	Chenin Blanc + Shiraz 3:1	1.00	1.12	1.06	10.72	10.67	10.69
T_9	Chenin Blanc + Ruby Red 2:1	0.41	0.50	0.45	8.54	8.21	8.37
T_{10}	Chenin Blanc + Ruby Red 3:1	0.44	0.50	0.47	9.39	9.27	9.33
T_{11}	Chenin Blanc + B. Blue 2:1	1.13	1.22	1.17	10.30	10.17	10.23
T_{12}	Chenin Blanc + B. Blue 3:1	1.21	1.26	1.23	10.82	10.67	10.74
T_{13}	Sauvignon Blanc + Shiraz 2:1	0.86	1.00	0.93	10.40	10.29	10.34
T_{14}	Sauvignon Blanc + Shiraz 3:1	0.90	1.12	1.01	10.22	10.07	10.14
T_{15}	Sauvignon Blanc + Ruby Red2:1	0.79	0.82	0.80	9.20	9.02	9.11
T_{16}	Sauvignon Blanc + Ruby Red 3:1	0.88	0.96	0.92	9.43	9.25	9.34
T_{17}	Sauvignon Blanc + B. Blue 2:1	1.04	1.19	1.11	9.42	9.39	9.40
T_{18}	Sauvignon Blanc + B. Blue 3:1	1.06	1.20	1.13	9.71	9.62	9.66
T_{19}	Italia + Shiraz 2:1	1.00	1.11	1.05	8.69	8.52	8.60
T_{20}	Italia + Shiraz 3:1	1.05	1.09	1.07	8.41	8.27	8.34
T_{21}	Italia + Ruby Red 2:1	0.61	0.75	0.68	8.20	8.02	8.11
T_{22}	Italia + Ruby Red 3:1	0.71	0.75	0.73	8.33	8.11	8.22
T_{23}	Italia + B. Blue 2:1	1.17	1.22	1.19	8.54	8.38	8.46
T_{24}	Italia + B. Blue 3:1	1.07	1.32	1.19	8.49	8.41	8.45
Mean		0.82	0.91	0.86	9.56	9.40	9.48
		F test	SEm	CD(*P=0.05*)	F test	SEm	CD(*P=0.05*)
Treatment		*	0.07	0.20	*	0.04	0.12
Years *		0.02	0.06	*	0.01	0.04	
Treatment x Years		NS	0.03	NS	NS	0.06	NS

'Shiraz' recorded higher % of alcohol, while, those blended with 'Ruby Red' recorded a lower content. Alcohol content increase when blended with Shiraz which may be due to varietal specification, total soluble solids and yeast activity during fermentation (Chikkasubbana *et al,* 1990). Other factors which determine the alcohol content in wine include initial sugar content of the juice, amount of by-product formed, amount of sugar utilized by yeast and other micro-organisms for their growth, and alcohol lost to evaporation (Amerine *et al,* 1979).

Tannin content

Tannins are a complex group of polyphenolic compounds which impart a bitter taste. Data on tannin content of wine in various blended wines for both the years are presented in Table 4. Blended treatments showed significant differences, whereas, years and interaction effect were found to be non-significant. Significantly high content of tannins (0.044%) was recorded in T_{21} (Italia + Ruby Red, 2:1) and minimum was observed in T_8 (0.007%) (Chenin Blanc + Shiraz, 3:1).

Interestingly, white varieties blended with the coloured cv. Shiraz registered minimum content of tannins in the wine, while, those blended with cv. Ruby Red showed the maximum tannin content. High tannin content in wine blended with 'Ruby Red' can be attributed to extraction/presence of higher amount of tannins in grape skin and seeds. White varieties contributed less amount of tannins to the wine because must here is fermented without the skin and seeds (Sharma, 1987). Tannin content decreases upon storage by complexing with proteins (Padshetty *et al,* 1982). Tannins polymerize with ageing, leading to low astringency and greater softness in the wine (Leslie, 2000).

Total phenol content

Phenolic compounds play a vital role in determining wine colour and flavour. For total phenol content, blending treatments were significant while years and interaction were non-significant (Table 4). Maximum total phenol was recorded in T_{21} (570.89mg/l) and minimum (228.32mg/l) in $T_{8.}$ In both the years, similar trend was observed among treatments wherein maximum content was found in T_{21}, and

minimum in T_8. Among treatments, it was observed that 'Shiraz' blended with white varieties registered minimum total phenol content in the wine, while blend of 'Ruby Red' with any white variety showed maximum content of total phenols in the wine. Shiraz, when blended with a white variety, resulted in better mouth-feel, colour and astringency compared to the rest of the treatments. Singleton and Easu (1969) reported higher phenol content in white varieties compared to red varieties. Suresh *et al* (1983) reported that blending of musts result in better quality red wines.

Organoleptic evaluation

Blended wines were evaluated by a panel of five members. A 20 point scale was considered based mainly on appearance, aroma, flavour, taste, colour and overall acceptability. Significant differences were found among treatments for all the quality attributes studied (Table 5). Treatment T_7 recorded the highest score for appearance (17.18), aroma (16.25), flavour (16.55), taste (17.30) and colour (17.83). This was followed by T_1 for appearance, aroma and taste; T_{12} for flavor and T_4 for colour. Lowest score was observed in T_{21} and $T_{23.}$ Overall acceptability of wine in T_7 (Chenin Blanc + Shiraz, 2:1) was found to be excellent (with a score of 18.31), followed by T_1 (Thompson Seedless + Shiraz, 2:1) with a score of 17.41.

Based on average score, wine made from blending Shriraz juice can be graded as Good (T_7, T_1, and T_{13}), while the rest of the blends produced fair quality wine (except T_{23}, which showed ordinary quality). Hence, blending any white variety with Shiraz gave good quality wine in terms of phenolic compounds (total phenols and tannins) and alcohol content within the specified range of composition of standard wine.

It can be concluded that blending white varieties (Chenin Blanc, Thompson Seedless, Sauvignon Blanc and Italia) with the coloured variety Shiraz was found to produce good quality wine, recording the highest average organoleptic score. As regard ratio, 2:1 proportion recorded as superior to 3:1 in terms of wine quality and organoleptic evaluation.

Table 4. Evaluation of various wine blends for tannins and total phenol content

	Treatment details	Tannin content of wine (%)			Total phenol content of wine (mg/l)		
		Batch I	Batch II	Mean	Batch I	Batch II	Mean
T_1	Thompson Seedless + Shiraz 2:1	0.012	0.017	0.014	486.66	492.63	489.64
T_2	Thompson Seedless + Shiraz 3:1	0.011	0.015	0.013	473.55	481.32	477.43
T_3	Thompson Seedless + Ruby Red 2:1	0.018	0.023	0.020	516.23	525.00	520.61
T_4	Thompson Seedless + Ruby Red 3:1	0.016	0.019	0.017	501.00	513.12	507.06
T_5	Thompson Seedless + B. Blue 2:1	0.015	0.018	0.016	495.04	509.00	502.02
T_6	Thompson Seedless + B. Blue 3:1	0.014	0.016	0.015	474.00	479.30	476.65
T_7	Chenin Blanc + Shiraz 2:1	0.008	0.012	0.010	251.24	267.67	259.45
T_8	Chenin Blanc + Shiraz 3:1	0.006	0.008	0.007	221.65	235.00	228.32
T_9	Chenin Blanc + Ruby Red 2:1	0.028	0.029	0.028	319.32	329.57	324.44
T_{10}	Chenin Blanc + Ruby Red 3:1	0.022	0.024	0.023	300.05	305.35	302.70
T_{11}	Chenin Blanc + B. Blue 2:1	0.015	0.018	0.016	301.10	310.12	305.61
T_{12}	Chenin Blanc + B. Blue 3:1	0.010	0.013	0.011	274.31	284.63	279.47
T_{13}	Sauvignon Blanc + Shiraz 2:1	0.017	0.021	0.019	240.33	247.65	243.99
T_{14}	Sauvignon Blanc + Shiraz 3:1	0.015	0.018	0.016	222.33	243.00	232.66
T_{15}	Sauvignon Blanc + Ruby Red2:1	0.026	0.030	0.028	270.10	275.66	272.88
T_{16}	Sauvignon Blanc + Ruby Red 3:1	0.022	0.025	0.023	258.67	264.02	261.34
T_{17}	Sauvignon Blanc + B. Blue 2:1	0.020	0.022	0.021	254.10	272.00	263.05
T_{18}	Sauvignon Blanc + B. Blue 3:1	0.019	0.020	0.019	237.64	241.35	239.49
T_{19}	Italia + Shiraz 2:1	0.023	0.025	0.024	480.54	485.24	482.89
T_{20}	Italia + Shiraz 3:1	0.016	0.021	0.018	453.12	472.60	462.86
T_{21}	Italia + Ruby Red 2:1	0.043	0.045	0.044	553.78	588.00	570.89
T_{22}	Italia + Ruby Red 3:1	0.029	0.032	0.030	535.11	553.00	544.05
T_{23}	Italia + B. Blue 2:1	0.026	0.029	0.027	513.25	531.66	522.45
T_{24}	Italia + B. Blue 3:1	0.018	0.021	0.019	487.62	509.37	498.49
Mean		0.018	0.021	0.019	380.03	392.34	386.18
		F test	SEm	CD (*P=0.05*)	F test	SEm	CD (*P=0.05*)
Treatment		*	0.003	0.010	*	6.47	19.75
Years		NS	0.005	NS	NS	3.82	NS
Treatment x Years		NS	0.002	NS	NS	5.48	NS

Table 5. Organoleptic evaluation of wine in different blended treatments of Grape (Mean of two years data)

Treatment		Organoleptic evaluation						
		Appearance	Aroma	Flavour	Taste	Colour	Overall acceptability	Mean
Max. Score		20	20	20	20	20	20	20
T_1	Thompson Seedless + Shiraz 2:1	16.53	15.41	15.73	16.53	16.31	17.41	16.32
T_2	Thompson Seedless + Shiraz 3:1	14.75	13.21	12.63	13.11	14.41	14.46	13.76
T_3	Thompson Seedless + Ruby Red 2:1	13.46	10.96	13.66	13.45	15.01	15.56	13.68
T_4	Thompson Seedless + Ruby Red 3:1	13.40	14.51	14.56	14.50	16.95	16.40	15.05
T_5	Thompson Seedless + B. Blue 2:1	14.30	12.16	12.86	14.50	14.11	13.20	13.52
T_6	Thompson Seedless + B. Blue 3:1	14.10	14.26	14.63	15.05	14.78	13.91	14.45
T_7	Chenin Blanc + Shiraz 2:1	17.18	16.25	16.55	17.30	17.83	18.31	17.23
T_8	Chenin Blanc + Shiraz 3:1	15.16	13.20	14.51	15.71	15.56	15.40	14.92
T_9	Chenin Blanc + Ruby Red 2:1	13.51	10.63	13.15	13.41	13.91	14.35	13.16
T_{10}	Chenin Blanc + Ruby Red 3:1	13.95	12.63	14.55	15.69	14.55	14.66	14.33
T_{11}	Chenin Blanc + B. Blue 2:1	14.38	11.25	13.73	13.90	14.33	14.30	13.64
T_{12}	Chenin Blanc +B. Blue 3:1	15.36	14.40	16.08	16.25	15.53	15.41	15.50
T_{13}	Sauvignon Blanc + Shiraz 2:1	15.30	14.53	14.50	14.60	15.36	15.90	15.03
T_{14}	Sauvignon Blanc + Shiraz 3:1	14.38	12.18	14.60	13.65	15.10	15.56	14.24
T_{15}	Sauvignon Blanc + Ruby Red2:1	14.58	11.31	11.55	14.20	14.51	12.91	13.17
T_{16}	Sauvignon Blanc + Ruby Red 3:1	14.16	13.70	12.23	14.31	14.71	13.58	13.78
T_{17}	Sauvignon Blanc + B. Blue 2:1	14.50	12.86	13.78	12.20	14.90	14.10	13.72
T_{18}	Sauvignon Blanc + B. Blue 3:1	14.70	14.25	14.83	13.98	15.16	14.51	14.57
T_{19}	Italia + Shiraz 2:1	15.06	14.51	14.66	13.33	13.65	15.85	14.51
T_{20}	Italia + Shiraz 3:1	13.18	11.15	13.86	12.90	13.23	14.83	13.19
T_{21}	Italia + Ruby Red 2:1	11.66	12.75	12.26	12.01	12.63	11.55	12.14
T_{22}	Italia + Ruby Red 3:1	13.10	14.98	13.66	14.30	13.10	12.23	13.56
T_{23}	Italia + B. Blue 2:1	12.35	10.26	11.63	12.13	13.16	12.26	11.96
T_{24}	Italia + B. Blue 3:1	13.28	12.93	12.26	13.51	13.41	12.43	12.97
Mean		14.26	13.09	13.85	14.18	14.67	14.54	
F- test		*	*	*	*	*	*	
SEm		0.06	0.07	0.08	0.08	0.07	0.12	
CD (*P=0.05*)		0.17	0.21	0.22	0.28	0.19	0.34	

*Significant NS: Non significant

Hedonic scale: 18-20 Excellent, 15-17 Good, 12-14 Fair, 9-11 Ordinary, 6-8 Poor, 3-5 Bad, 1-2 Very bad

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