Int. J. of Food Ferment. Technol. 4(1): 37-46, June, 2014
DOI Number: 10.5958/2277-9396.2014.00004.X

Research Paper

Effect of Initial Sugar Concentration and SO_2 Content on the Physico-Chemical Characteristics and Sensory Qualities of Mandarin Orange Wine

V K Joshi*, Navjot Sandhu and Ghan Shyam Abrol

Department of Food Science and Technology, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan-173230, Uttar Pradesh, India.

**Corresponding author: V K Joshi; vkjoshipht@rediffmail.com*

Paper no. : 77 **Acceptance :** 25th May, 2014 **Received in revised form:** 27 August, 2014 **Accepted:** 27 August, 2014

Abstract

Mandarin oranges are perishable in nature and to utilize surplus the fruit for the preparation of alcoholic wine is a good option. So, the present study was planned to prepare orange wine of acceptable quality. For this, variable initial sugar concentrations were kept. Different content of SO_2 were added to the orange must. Physico-chemical and sensory analyse of prepared wines were performed. With increase in initial TSS, the fermentatoin rates decreased. However, no such differences with respet to SO_2 levels were recorded. The physico-chemical characteristics of orange were comparable for other similar wines. The wine with initial TSS 28°C and SO_2 @150 ppm was adjudged to be the best for preparation of mandarine orange wine of acceptable quality.

During maturation, TSS, total sugars, total phenols, sulphur dioxide, yellow colour units, ethanol, titrable acidity and pH decreased, while reducing sugar, red colour units and total esters increased. All these changes were desirable.

Keywords: Mandarin wine, Sugar concentration, SO_2 concentration and sensory analysis

Mandarin orange (*Citrus reticulata* Blanco) is grown in India in the states of Maharashtra, Madhya Pradesh, Tamil Nadu, Assam, Orissa, West Bengal, Rajasthan, Nagaland, Mizoram, Arunachal Pradesh, Karnataka, Punjab, and Tripura. The fruit has shelf-life of 4-5 days only at normal temperature and up to 2-3 weeks under refrigerated conditions. It is a good source of Vitamin C and folate, a source of vitamin A and B1 (Braddock, 1999), beside this the fruit also contains sodium, potassium, magnesium, copper, sulphur and chlorine. It is used for preparation of canned segments, juice, juice concentrate, squash, beverages, jams and marmalades. But there is a problem of bitterness and considerable work has been done to reduce the bitterness in preparation of wine from kinnow fruit (Joshi *et al.,* 1999).

The production of alcoholic beverage with increase in initial TSS, the fermentation rates decreased from mandarin orange is another alternative to reduce the wastage of fruit and also to increase the economic turnover from the fruit. Mandarine orange wine has been prepared earlier (Amerine *et.al.,* 1980) but there is no documentation of optimization of various factors involved. Therefore, attempt has been made to produce quality wine by using different initial sugar concentrations and different SO_2 levels. The results have been discussed in this paper.

Materials and Methods

Raw material

Mandarin Oranges of medium size were obtained from the local fruit market of Karnal, Haryana. Juice was extracted with the help of screw type juice extractor. Cane sugar used to ameliorate the must for preparation was procured from the local market.

Must preparation

Must of different treatments of TSS and SO_2 concentration were prepared. (Fig. 1). The initial TSS of juice (10°B) was raised to different levels, viz. 22°B, 24°B, 26°B and 28°B by addition of sugar. To all these orange musts sub- treatments of different SO_2 content were given as shown below:

Treatment T_A : TSS was raised to 22°B, SO_2 was added @ (*i*) 50 ppm, (*ii*) 100 ppm, (*iii*) 150 ppm and (*iv*) 200 ppm.

Treatment T_B : TSS was raised to 24°B, as other parameter same T_A

Treatment T_C : TSS was raised to 26°B, as other parameter same T_A

Treatment T_D : TSS was raised to 28°B as other parameters same T_A

All the different musts were kept in glass containers. Diammonium hydrogen phosphate (DAHP) was added at the rate of 0.1% as nitrogen source to all the treatments.

Fermentation

An active culture of yeast *Saccharomyces cerevisiae* var. *ellipsoideus* was added @ 5% to start the fermentation process which was observed by the extent of bubbling and monitoring the reduction of TSS during the course of fermentation. After the completion of fermentation, the prepared wine was siphoned, filtered and filled in small sterilized bottles upto the brim, and pith corks were put. The flow diagram of the entire process of preparation of mandarin orange wine has been given in Figure 1. Mandarin orange wine of different treatments was matured for interval of 0 day, 2 month and 4 month period and were analysed for different physico chemical and sensory qualities.

Phsico-chemical analysis

TSS was determined with Erma hand refrectometer (0-32° Brix). Titratable acidity was estimated by titrating a known aliquot of the sample against N/10 NaOH solution using phenolphthalein as an indicator. The total titratable acidity was calculated and expressed as percent citric acid. (Ranganna, 1986). ELTOP-3030 pH meter was used for determination of pH. Lovibond tintometer model E was used to measure the color of the wine using one inch cell. The color was expressed as red, yellow and blue units (Ranganna, 1986). Ethanol (%) was determined by spectrophotometric method (Caputi *et al.,* 1968). The total and reducing sugars were estimated by Lane and Eynon's volumetric method (A.O.A.C., 1980). Total esters were determined in wine as per the method of Liberaty (1961). The total phenols contents in different wines were determined by Folin Ciocalteu procedure (Singleton and Rossi, 1965). The total sulphur dioxide content in different wines was determined by Ripper's Titrametric method.

Sensory quality evaluation

For sensory quality of mandarin orange wine, 10 members of the selected panel were asked to give score out of 20 for various parameters like color, appearance, body, taste, aroma, astringency etc. as the performa given by Amerine *et. al.,* (1980). The judges were asked to rinse their months with clean water. After evaluation, total of various

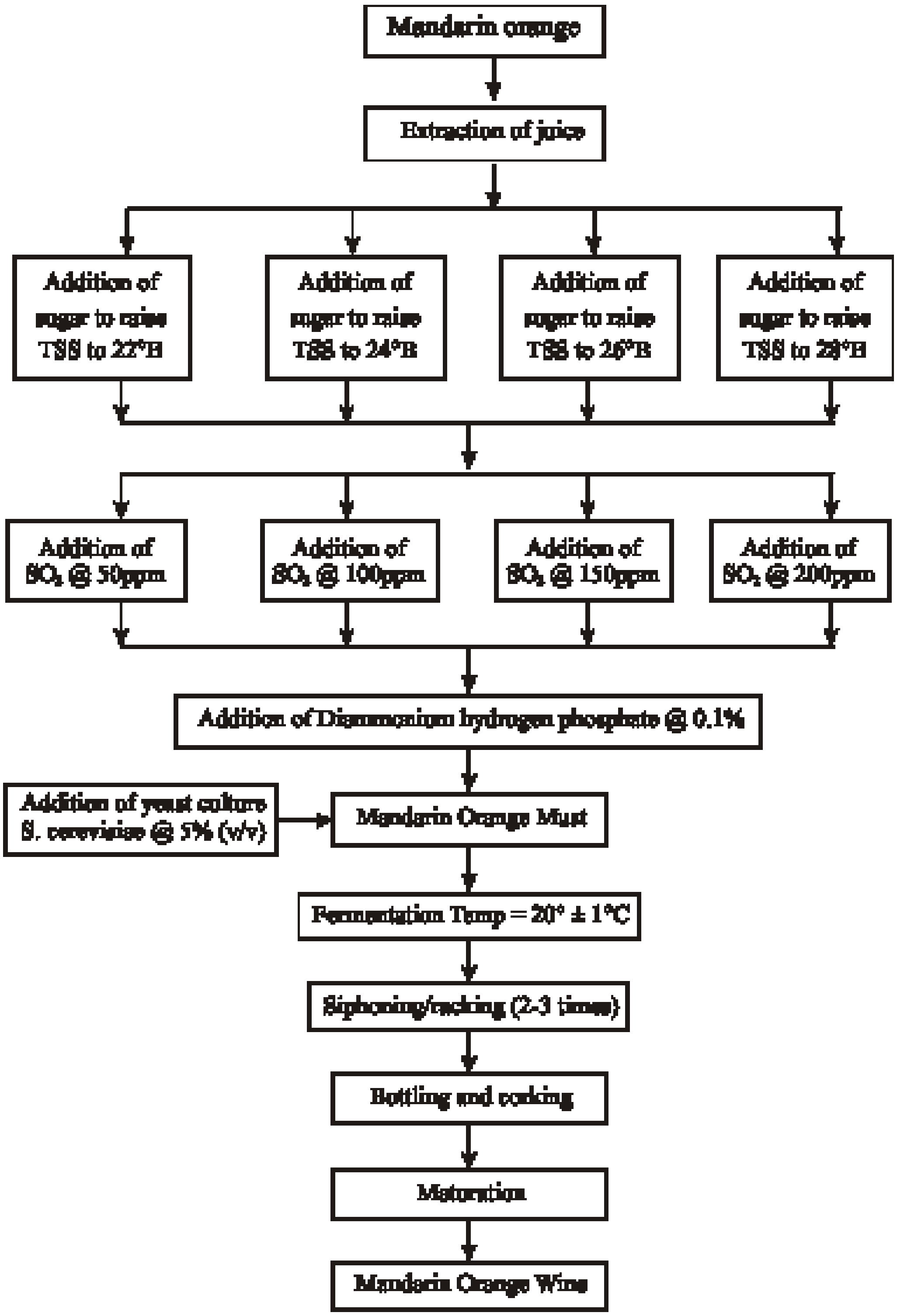

Figure 1: Flow sheet of various treatments for preparation of mandarin orange wine

parameters out of 20 were made and are presented in this paper.

Results and Discussion

The fermentation rate (fall of TSS/24hr) in all the treatments was higher for a week which was found to decrease, thereafter (Figure 2, 3, 4, 5). Further, with the increase in the initial sugar concentration the fermentation rate decreased which indicated that the increase in sugar level adversely affects the fermentation of yeast. The decline in the rate of fermentation may be due to more alcohol production which might have inhibited the fermentation efficiency of yeast. No such differences were however, seen due to SO_2 levels.

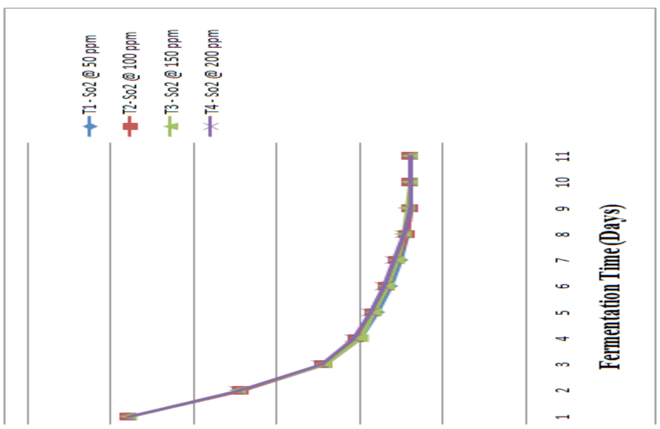

Fig. 2: Fermentability of orange musts of TSS 22⁰Brix at different treatments

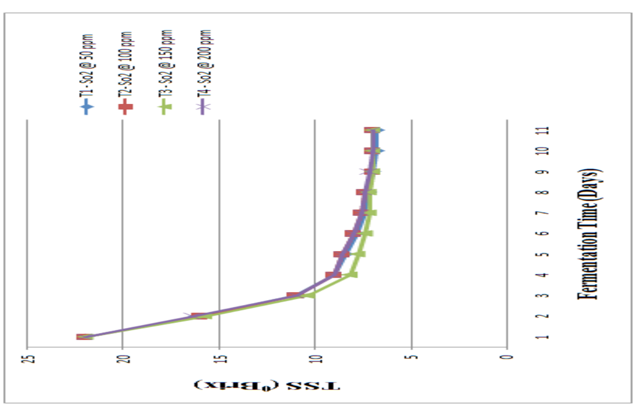

Fig 3: Fermentability of orange musts of TSS 240Brix at different treatments

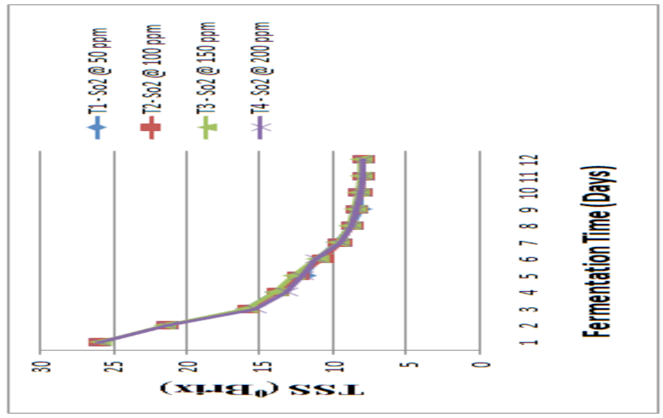

Fig. 4: Fermentability of orange musts of TSS 26°Brix at different treatments

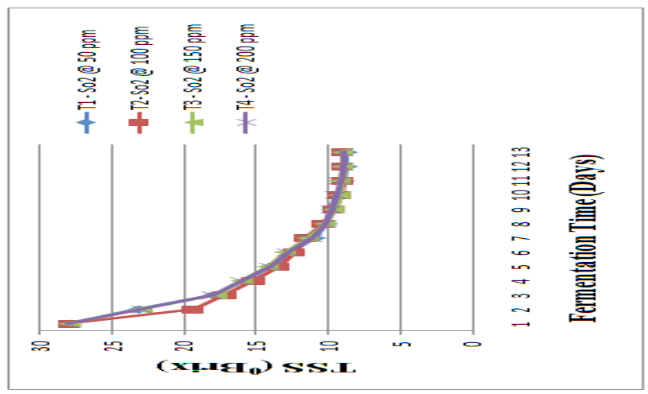

Fig. 5: Fermentability of orange musts of TSS 28°Brix at different treatments

Results (Table 1) show the changes in TSS of orange wine during maturation. At 0 month, TSS ranged between 7-9°B and the highest TSS was observed in wine of initial TSS 28°B at treatments T_1, T_2, T_3 and T_4. The lowest TSS was however observed in wine of initial TSS 22°B of treatments T_1 and T_3. During maturation, a trend of decrease in TSS was observed. Precipitation of soluble solids during interaction of various components might have resulted in a decrease of TSS maturation (Joshi *et al.,* 1999). Changes in titratable acidity of mandarin orange wine during maturation are shown in Table 2. At 0 month, titratable acidity ranged between 0.57-0.73 per cent. Highest titratable acidity was observed in wine of initial TSS 28°B at treatment T_2 and lowest in wine of initial TSS 22°B of treatments T_3 and T_4. Further, there was also a decrease in titratable acidity of wines of different treatments. The decrease in titratable acidity is desirable in wines from acidic fruits during maturation as it increases the palatability of wine (Joshi *et al.,* 1999). Table 3 shows the changes in pH during maturation of mandarin orange wine. At 0 month, the range of pH was between 3.95-4.13. Highest pH was recorded in wine of initial TSS 28°B at treatment T_3 and lowest in wine of initial TSS 24°B at treatment T_1.

Changes in the total sugars of orange wine during maturation. (Table 4) showed that the total sugars ranged between 1.464-1.726 per cent at 0 months. Highest total sugars (1.726%) was recorded in wine of initial TSS 28°B

Table 1: Changes in TSS (⁰Brix) of Mandarin orange wine during maturation

Treatments	INITIAL TSS(⁰Brix)				INITIAL TSS(⁰Brix)				INITIAL TSS(⁰Brix)			
	22	24	26	28	22	24	26	28	22	24	26	28
	0 Days				2 Months				4 Months			
T_1 (SO_2 @ 50 ppm)	7.0	7.2	8.2	9.0	6.8	7.2	8.0	9.0	6.8	7.0	7.8	9.0
T_2 (SO_2 @ 100 ppm)	7.2	7.4	8.2	9.0	7.0	7.2	8.2	9.0	6.8	7.0	8.0	8.8
T_3 (SO_2 @ 150 ppm)	7.0	7.4	8.2	9.0	6.8	7.0	8.0	9.0	6.8	7.0	7.8	8.8
T_4 (SO_2 @ 200 ppm)	7.2	7.2	8.2	9.0	7.0	7.0	8.0	9.0	6.8	7.0	8.0	8.6

Table 2: Changes in Titratable acidity (%) of Mandarin orange wine during maturation

Treatments	INITIAL TSS(⁰Brix)				INITIAL TSS(⁰Brix)				INITIAL TSS(⁰Brix)			
	22	24	26	28	22	24	26	28	22	24	26	28
	0 Days				2 Months				4 Months			
T_1 (SO_2 @ 50 ppm)	0.64	0.67	0.64	0.70	0.64	0.67	0.60	0.67	0.64	0.64	0.60	0.64
T_2 (SO_2 @ 100 ppm)	0.64	0.64	0.64	0.73	0.60	0.60	0.64	0.73	0.51	0.57	0.60	0.73
T_3 (SO_2 @ 150 ppm)	0.57	0.67	0.64	0.64	0.54	0.64	0.64	0.64	0.54	0.64	0.64	0.60
T_4 (SO_2 @ 200 ppm)	0.57	0.64	0.70	0.67	0.57	0.64	0.67	0.64	0.54	0.64	0.60	0.64

Table 3: Changes in pH of Mandarin orange wine during maturation

Treatments	INITIAL TSS(0Brix)				INITIAL TSS(0Brix)				INITIAL TSS(0Brix)			
	22	24	26	28	22	24	26	28	22	24	26	28
	0 Days				2 Months				4 Months			
T_1 (SO_2 @ 50 ppm)	3.99	3.95	4.00	4.02	3.95	3.91	3.99	4.02	3.97	3.85	3.95	3.99
T_2 (SO_2 @ 100 ppm)	4.00	4.02	3.99	4.09	3.98	3.95	4.00	4.08	3.98	3.93	3.97	4.02
T_3 (SO_2 @ 150 ppm)	4.04	3.99	3.97	4.13	4.01	3.91	3.97	4.07	4.02	3.88	3.87	4.01
T_4 (SO_2 @ 200 ppm)	4.03	3.98	3.99	4.06	4.00	3.93	4.00	4.11	3.99	3.87	3.93	4.09

Table 4: Changes in Total sugar (%) of Mandarin orange wine during maturation

Treatments	INITIAL TSS(ºBrix)					INITIAL TSS(ºBrix)					INITIAL TSS(ºBrix)			
	22	24	26	28		22	24	26	28		22	24	26	28
	0 Days					2 Months					4 Months			
T_1 (SO_2 @ 50 ppm)	1.464	1.529	1.610	1.667		1.290	1.348	1.380	1.439		1.153	1.189	1.216	1.249
T_2 (SO_2 @ 100 ppm)	1.491	1.559	1.610	1.691		1.291	1.355	1.404	1.466		1.165	1.195	1.229	1.257
T_3 (SO_2 @ 150 ppm)	1.500	1.540	1.633	1.726		1.319	1.379	1.389	1.466		1.165	1.208	1.229	1.277
T_4 (SO_2 @ 200 ppm)	1.528	1.569	1.644	1.703		1.305	1.403	1.413	1.483		1.181	1.192	1.243	1.290

Table 5: Changes in Reducing sugar (%) of Mandarin orange wine during maturation

Treatments	INITIAL TSS(ºBrix)					INITIAL TSS(ºBrix)					INITIAL TSS(ºBrix)			
	22	24	26	28		22	24	26	28		22	24	26	28
	0 Days					2 Months					4 Months			
T_1 (SO_2 @ 50 ppm)	0.500	0.537	0.561	0.595		0.561	0.588	0.632	0.694		0.581	0.625	0.704	0.769
T_2 (SO_2 @ 100 ppm)	0.510	0.555	0.561	0.609		0.568	0.588	0.641	0.714		0.581	0.641	0.724	0.793
T_3 (SO_2 @ 150 ppm)	0.515	0.568	0.581	0.617		0.581	0.602	0.657	0.724		0.595	0.666	0.735	0.819
T_4 (SO_2 @ 200 ppm)	0.515	0.561	0.588	0.632		0.574	0.617	0.657	0.714		0.588	0.684	0.757	0.819

Table 6: Changes in Total SO_2 (mg/l) of Mandarin orange wine during maturation

Treatments	INITIAL TSS(ºBrix)					INITIAL TSS(ºBrix)					INITIAL TSS(ºBrix)			
	22	24	26	28		22	24	26	28		22	24	26	28
	0 Days					2 Months					4 Months			
T_1 (SO_2 @ 50 ppm)	41.47	41.47	42.62	41.47		25.34	33.40	27.64	39.16		21.88	29.95	24.19	39.16
T_2 (SO_2 @ 100 ppm)	52.99	65.64	76.03	67.96		36.86	56.44	58.75	51.84		32.25	47.25	57.60	41.47
T_3 (SO_2 @ 150 ppm)	70.27	59.90	104.8	138.24		49.53	55.29	87.55	122.11		44.92	48.38	51.84	104.83
T_4 (SO_2 @ 200 ppm)	82.94	86.40	126.72	153.21		72.57	84.09	116.35	163.58		55.29	80.64	110.59	148.60

Table 8: Changes in Color (R, Y, B units) of Mandarin orange wine during maturation

Treatments	INITIAL TSS(0Brix)				INITIAL TSS(0Brix)				INITIAL TSS(0Brix)			
	22	24	26	28	22	24	26	28	22	24	26	28
	0 Days				2 Months				4 Months			
T_1 (SO_2 @ 50 ppm)	1.3R 1.4Y 0B	1.0R 2.0Y 0.2B	1.3R 1.4Y 0B	1.3R 1.4Y 0B	1.3R 1.4Y 0B	1.0R 2.0Y 0.2B	1.0R 2.0Y 0.2B	1.0R 2.0Y 0.2B	1.3R 1.5Y 0.3B	1.3R 1.6Y 0.4B	1.5R 2.3Y 0.1B	1.3R 1.6Y 0.4B
T_2 (SO_2 @ 100 ppm)	1.3R 1.4Y 0B	1.0R 2.0Y 0.2B	1.0R 2.0Y 0.2B	1.0R 2.0Y 0.2B	1.0R 2.0Y 0.2B	1.0R 2.0Y 0.2B	1.3R 1.4Y 0B	1.5R 2.3Y 0.1B	1.3R 1.5Y 0.3B	1.3R 1.6Y 0.4B	1.5R 2.3Y 0.1B	1.5R 2.3Y 0.1B
T_3 (SO_2 @ 150 ppm)	1.0R 2.0Y 0.2B	1.0R 2.0Y 0.2B	1.3R 1.4Y 0B	1.3R 1.4Y 0B	1.0R 2.0Y 0.2B	1.0R 2.0Y 0.2B	1.3R 1.4Y 0B	1.0R 2.0Y 0.2B	1.3R 1.5Y 0.3B	1.3R 1.5Y 0.3B	1.3R 1.6Y 0.4B	1.3R 1.6Y 0.4B
T_4 (SO_2 @ 200 ppm)	1.0R 2.0Y 0.2B	1.0R 2.0Y 0.2B	1.0R 2.0Y 0.2B	1.3R 1.4Y 0B	1.0R 2.0Y 0.2B	1.0R 2.0Y 0.2B	1.0R 2.0Y 0.2B	1.0R 2.0Y 0.2B	1.3R 1.5Y 0.3B	1.3R 1.6Y 0.4B	1.3R 1.6Y 0.4B	1.5R 2.3Y 0.1B

Table 9: Changes in Alcohol (% v/v) of Mandarin orange wine during maturation

Treatments	INITIAL TSS (^{0}Brix)				INITIAL TSS(^{0}Brix)				INITIAL TSS(^{0}Brix)			
	22	24	26	28	22	24	26	28	22	24	26	28
	0 Days				2 Months				4 Months			
T_1 (SO_2 @ 50 ppm)	8.5	8.9	9.3	10.2	8.4	8.7	9.2	10.0	8.3	8.6	9.0	10.0
T_2 (SO_2 @ 100 ppm)	8.4	8.6	9.2	10.1	8.3	8.6	9.0	9.8	8.1	8.4	8.9	9.7
T_3 (SO_2 @ 150 ppm)	8.5	8.6	9.0	9.8	8.3	8.5	8.9	9.7	8.2	8.3	8.7	9.5
T_4 (SO_2 @ 200 ppm)	8.3	8.5	8.9	9.8	8.2	8.3	8.9	9.7	8.0	8.1	8.6	9.7

Table 10: Changes in Total Esters (mg/L) of Mandarin orange wine during maturation

Treatments	INITIAL TSS(^{0}Brix)				INITIAL TSS(^{0}Brix)				INITIAL TSS(^{0}Brix)			
	22	24	26	28	22	24	26	28	22	24	26	28
	0 Days				2 Months				4 Months			
T_1 (SO_2 @ 50 ppm)	37	39	42	42	62	66	69	72	85	88	93	99
T_2 (SO_2 @ 100 ppm)	39	40	42	44	65	66	71	78	86	86	96	102
T_3 (SO_2 @ 150 ppm)	43	44	46	44	66	71	74	77	82	90	96	104
T_4 (SO_2 @ 200 ppm)	43	46	49	47	69	74	79	82	89	89	100	108

Table 11: Changes in Total Phenols (mg/L) of Mandarin orange wine during maturation

Treatments	INITIAL TSS (^{0}Brix)				INITIAL TSS(^{0}Brix)				INITIAL TSS(^{0}Brix)			
	22	24	26	28	22	24	26	28	22	24	26	28
	0 Days				2 Months				4 Months			
T_1 (SO_2 @ 50 ppm)	80	78	80	85	75	72	78	80	74	70	73	78
T_2 (SO_2 @ 100 ppm)	78	78	85	90	74	74	82	88	72	73	79	82
T_3 (SO_2 @ 150 ppm)	87	88	87	96	82	78	84	93	82	76	82	80
T_4 (SO_2 @ 200 ppm)	91	97	94	102	92	96	76	98	90	83	76	91

at treatment T_3. While the lowest total sugar (1.464%) was observed in wine of initial TSS 22°B at treatment T_1. The decrease in total sugars of wines of different treatments was also observed during maturation of wine. The decrease in total sugar might be due to Maillared's reaction resulting non-enzymatic browning due to reaction of sugar with amino acids (Zoecklein *et. al.,* 1995).

Changes in Table 5 show reducing sugars of mandarin orange wine during maturation. Reducing sugars ranged between 0.500-0.632 per cent at 0 months. The wine with initial TSS 28°B showed highest reducing sugar (0.632%) in treatment T_4 while the lowest reducing sugar (0.5%) was in wine of initial TSS 22°B at treatment T_1. The trend of increase in reducing sugars of wines of different treatments was also observed during maturation. The increasing trend of reducing sugar is apparently the result of hydrolysis of total sugars into reducing sugars during maturation (Amerine *et al.,* 1980). Table 6 shows changes during maturation in SO_2 content of mandarin orange wine. At 0 months total SO_2 ranges between 41.47-153.21 mg/L. Highest Total SO_2 (153.21 mg/L) was recorded in wine of initial TSS 28°B at treatment T4 while the lowest total SO_2 (41.47 mg/L was observed in wine of initial TSS 22^{o}B, 24^{o}B, and 28^{o}B of treatment T_1. A decreasing trend of total SO_2 was observed during maturation of mandarin orange wines at different treatments. Colour units of red, yellow and blue in wine (Table 7). During maturation, the yellow colour units decreased while the red colour units increased. Changes in ethanol content of orange wine during maturation (Table 8) showed that ethanol content ranged between 8.3-10.2% (v/v) at 0 months. The wine with initial TSS 28^{o}B showed the highest ethanol content of 10.2% of treatment T_1, while the lowest ethanol content of 8.3% took place in wine of initial TSS 22^{o}B treatment T_4. Slight decrease in ethanol content of wines of different treatments took place during maturation. The slight decrease might be due to reaction of alcohol with acids to from esters (Amerine *et al.,* 1980; Zoecklein *et al.,* 1995). Changes in total esters of mandarin orange wine during maturation. At 0 months total esters ranges between 37-49 mg/L. The highest total esters (49mg/L) took place in wine of initial TSS 26^{o}B of treatment T_4. The lowest total esters (37mg/L) however, was observed in wine of initial TSS 22^{o}B at treatment T_1. There was an increase in total esters in wines during maturation due to the changes attributed to the phenomenon of ageing which is in confirmation as reported earlier (Amerine *et al.,* 1980)

Total phenols of mandarin orange wine. Total phenols range between 78-102 mg/L at 0 month of matura... (Table 10) Highest total phenols (102mg/L) was observed in wine of initial TSS 28^{o}B at treatment T_4. While the lowest total phenols (78mg/L) was observed in wine of initial TSS 22^{o}B at treatment T_2 and 24^{o}B at treatment T_1 and T_2. The decreasing trend of total phenols was observed in wines during maturation. The physico-chemical characteristics of wine are comparable to the similar fermented beverages. During maturation of wine, it was observed that there was increase in reducing sugars, esters. But a decrease was observed in TSS, total sugars, total phenols and total sulphur dioxide. These changes were considered desirable for increasing palatability of wine. There was a bitter taste in wine. So debittering of juice will add to the palatability of mandarin orange wine. Blending with orange juice will also be beneficial.

Cost of production is very important parameter for a technique or technology to be commercialized. The calculated cost indicated that the product can be sold at reasonable cost with profit. Calculated cost per unit bottle of 200ml is ₹ 29.8.

Conclusion

It is concluded that for the fermentation of treated juice, initial sugar concentration played an important role. The fermentation efficiency of yeast decreased with increase in the initial sugar concentration. There was a bitter taste in wine. So, debittering of juice will add to the palatability of mandarin orange wine. Blending with orange juice will also be beneficial. The wine with initial TSS 28^0B and SO_2 @150 ppm was adjudged to be better which can be further improved if it is made as sweet wine.

References

Amerine, M.A., Kunkee, K.E., Ough, C.S., Singleton, V.L. and Webb, A.D. 1980. Technology of wine making. AVI Publication Co. Inc. Westport, CT, p. 794

A.O.A.C. 1980. Association of official Analytical chemists, Official Methods of Analysis. Hortwitz, W. (ed.), 13th edn. Washington, D.C. p. 1015

Caputi, A.Jr., Ueda, M. and Brown, J. 1968. Spectrophotometric determination of ethanol in wine. *Am. J. Enol. Vitic.*, **19**: 160-165

Joshi,V.K., Sandhu, D.K. and Thakur, N.S. 1999. Fruit based alcoholic beverages In : Biotechnology : Food Fermentation. V.K.Joshi and Ashok Pandey (eds.), Educational Publ. and Distributors, New Delhi, pp. 647-744.

Liberaty, V. 1961. Ester Determination and their applications to wine. Msc. Thesis, Univ. of California, Davis.

Ranganna, S. 1986. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. IInd Edn., Tata McGraw Hill Publ. Co., New Delhi, p.1112

Robert J. Braddock. 1999. Handbook of citrus By- Products and Processing Technology, AVI publication Co., Westpist, CT.

Singleton, V.L. and Rossi, J.A.Jr. 1965. Colorimetry of total phenolics with phosphomolybatic phosphotungstic acid reagents. *Am. J. Enol. Victic.*, **16**:144-158.

Zoecklein, B.W., Fugelsang, K.C., Gump, B.H. and Nury, F.S. 1995. *Wine Analysis and Production*. Chapman Hall, New York.