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Effect of different levels of wine yeast inoculum and PH of must on wines prepared from *Mrig Bahar* fruits of Nagpur mandarin

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Abstract
The present investigation on effect of different levels of wine yeast inoculum and pH of must on wines prepared from *Mrig Bahar* fruits of Nagpur mandarin was conducted at PHT Laboratory, Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the year 2016-17. The experiment consisted of two different factors *viz*., levels of wine yeast (*Saccharomyces cerevisiae* var. Ellipsoideus) inoculum and levels of pH of must with three replications using Factorial Completely Randomised Design. The biochemical analyses of the composition of wines prepared indicated that the different levels of wine yeast inoculum as 3, 6 and 9 per cent and levels of pH of must as 3.0, 3.5, 4.0, 4.5 and 5.0 affected the quality of wines prepared. The wine prepared from *Mrig Bahar* fruits of Nagpur mandarin using 6 per cent wine yeast inoculum and 4.0 pH of must yielded highest alcohol.

Keywords: Nagpur mandarin wine, *Citrus reticulata*, *Mrig Bahar*, *Saccharomyces cerevisiae*, wine yeast inoculum, must pH

Introduction
Mandarin (*Citrus reticulata*) fruit contains moisture 82.6-90.2 g, protein 0.61-0.215 g, calories 32-45 Kcal, calcium 25-46.8 mg, phosphorus 11.7-23.4 mg, iron 0.17-0.62 mg, thiamine 0.048-0.128 mg, riboflavin 0.014-0.041 mg, niacin 0.199-0.38 mg, ascorbic acid 13.3-54.4 mg and carotene 0.013-0.175 mg per 100 g of edible portion (Morton, 1987) [14]. It is antispasmodic, sedative, Cytophylactic, and digestive. Fresh mandarin calms the intestines and aids in digestion. Mandarin fruit promotes cell generation and its aroma is inspiring and strengthening (Watson, 1994) [20].

Mandarin juice has a poor shelf-life and faces problem of post-harvest losses. Along with these, about 25 per cent fruits of Nagpur mandarin remain undersized, which are locally called as "*Choora*" and gain less price in market. Studies on seasonal variations in Nagpur mandarin revealed that *Mrig Bahar* fruits of Nagpur mandarin have more juice content, TSS and ascorbic acid content, along with less acidity (Bhatnagar *et al.*, 2012) [3]. Nagpur mandarin is one of the major citrus fruit crops of India, which suffers from post-harvest losses during the glut period. With a view of value addition of the fruit, diversification of the produce towards food processing industry is the need of the day. The easy availability, comparatively low cost, high nutritive value and good sugar content of mandarin, together make it a suitable alternative substrate for wine production.

Many Physico-chemical conditions play an important role in ethanol content of wine (Kumar *et al.*, 2009) [11]. Several researchers have reported that many factors, including fermentation temperature, pH, inoculum size, sugar concentration, type of fermentation can significantly influence the ethanol content of fruit wine. Similarly, pH of juice / must is an important parameter for the successful progress of fermentation because of two possible reasons that is retarding the growth of harmful bacteria by acidic solution and promoting the growth of yeast which grows well in acidic conditions (Mathewson, 1980) [12].

Keeping in view the above facts and in order to produce good quality wine from *Mrig Bahar* fruits Nagpur mandarin, present investigation was undertaken to study the influence of different levels of yeast inoculum and pH of must on chemical composition of wine prepared from *Mrig Bahar* fruits of Nagpur mandarin.

Material and Methods
Fully matured and well ripened *Mrig Bahar* fruits of Nagpur mandarin were procured during

April 2016-17 from local market of Akola, (MS) India. The trial was carried out at Post-harvest Technology Laboratory, Department of Horticulture, Dr. PDKV, Akola. The entire process of preparation of wine from *Mrig Bahar* fruits of Nagpur mandarin is shown diagrammatically in Fig. 1.

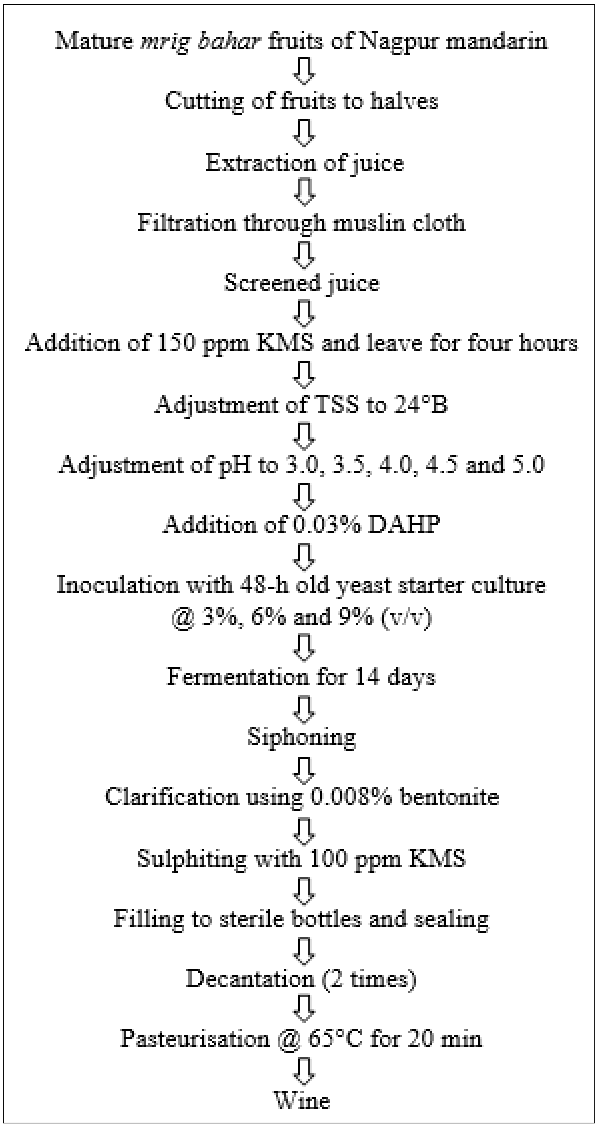

Fig 1: Preparation of wine from *Mrig Bahar* fruits of Nagpur mandarin

Various biochemical components of wines of *Mrig Bahar* fruits of Nagpur mandarin *viz.*, alcohol, residual sugars, acidity, volatile acidity, ascorbic acid and non-enzymatic browning were analysed by using methods suggested by FSSAI (2015) [6], Sadasivam and Manickam (1996) [17], Ranganna (2000) [15], Amerine *et al.* (1980) [1], Mazumdar and Majumdar (2003) [13], and Ranganna (2000) [15], respectively. The pH of wine was measured by using Perkin Elmer pH meter at 30 °C temperature.

The experiment was laid in two factor Completely Randomised Design. First factor, wine yeast inoculum had three different levels as S_1 (3%), S_2 (6%), and S_3 (9%) whereas, second factor, pH of must had five different levels as P_1 (3.0 pH), P_2 (3.5 pH), P_3 (4.0 pH) P_4 (4.5 pH), and P_5 (5.0 pH). All the observations were taken in triplicate and results were the mean of the triplicate readings. The data collected on various observations during the course of investigation was subjected to statistical analysis applying statistical package for agricultural workers developed by CCSHAU, Hisar.

Results and Discussion

From the data presented in table 1, it can be observed that the fruits of *Mrig Bahar* of Nagpur mandarin used for the experiment recorded juice recovery of 49.72%, colour orange, TSS 11.10°B, acidity 0.79%, TSS: acidity ratio 14.00 and pH 4.06. It had 8.34% total sugars, 5.40% reducing sugars, 2.94% non-reducing sugars and 40.69 mg ascorbic acid per 100 mL of fruit juice. On the basis of readings of different Physico-chemical parameters of the fruit it can be stated that the fruits have been procured at proper stage of maturity and have desirable characteristics for conversion into wine. Further, on the basis of TSS and total sugars of juice it can be concluded that the juice of Nagpur mandarin needs amelioration with sugar for preparation of wine.

Table 1: Physico-chemical characteristics of *Mrig Bahar* fruits of Nagpur mandarin

Sr. No.	Characteristics	Readings
1	Juice recovery (%)	49.72
2	Colour	Orange
3	TSS (°B)	11.10
4	Acidity* (%)	0.79
5	TSS: acid ratio	14.00
6	pH	4.06
7	Total sugars (%)	8.34
8	Reducing sugars (%)	5.40
9	Non-reducing sugars (%)	2.94
10	Ascorbic acid (mg100 mL^{-1})	40.69

*as citric acid

Biochemical parameters of wine

Various biochemical parameters of wine prepared from *Mrig Bahar* fruits of Nagpur mandarin, such as alcohol, acidity, pH, residual sugars, volatile acidity, ascorbic acid and non-enzymatic browning were analysed.

Alcohol

The data regarding alcohol content of wine prepared from *Mrig Bahar* fruits of Nagpur mandarin, as influenced by different levels of yeast inoculum and pH of must, for fresh, and 3, 6, and 9 months ageing is presented in Table 2. The data presented reveals that alcohol content of wine was significantly affected by different levels of yeast inoculum and pH of must individually, as well as by the interaction of these two factors.

Table 2: Effect of different levels of yeast inoculum and pH on the alcohol content of wines

	Alcohol (%)			
Treatment	S_1	S_2	S_3	Mean
P_1	8.90 (17.36)	9.45 (17.90)	9.39 (17.85)	9.25 (17.70)
P_2	9.12 (17.57)	9.54 (17.99)	9.12 (17.57)	9.26 (17.71)
P_3	9.09 (17.55)	9.81 (18.25)	9.26 (17.71)	9.39 (17.84)
P_4	9.29 (17.74)	9.48 (17.93)	9.37 (17.82)	9.38 (17.83)
P_5	8.79 (17.24)	8.93 (17.39)	9.26 (17.72)	8.99 (17.45)
Mean	9.04 (17.49)	9.44 (17.89)	9.28 (17.73)	
	S	P	S X P	
'F' test	Sig	Sig	Sig	
SE (m)±	0.013	0.017	0.029	
CD at 5%	0.038	0.049	0.084	

(Figures in parentheses indicate arc sine transformed values)

The maximum alcohol content as 9.44 per cent recorded in treatment S_2 (*Saccharomyces cerevisiae* var. *ellipsoideus* inoculated at 6%) was found significantly superior to other yeast inoculum treatments. While minimum alcohol content of 9.04 per cent was recorded in treatment S_1 (*Saccharomyces cerevisiae* var. *ellipsoideus* inoculated at 3%).

A higher amount of alcohol content in wine of 6 per cent inoculum level in this experiment is closer to the results of Honde and Adsule (1998) [9], who studied the effect of inoculum levels on the chemical composition of sapota wine and recorded higher (7.27%) alcohol content at 5 per cent inoculum level than at 2 per cent inoculum level (7.03%). Similarly, Khandelwal *et al.* (2006) [10] also showed that, use of 5 per cent inoculum of *Saccharomyces cerevisiae* for preparation of pure and blended Kinnow wine contributed to the highest ethanol production.

The data in respect of alcohol content of Nagpur mandarin wine, as affected by different pH levels of must, showed significant differences. Treatment P_3 i.e. pH 4.0 was associated with maximum alcohol content (9.39%), which was at par with treatment P_4 i.e., 4.5 pH (9.38%). During this trial, treatment P_5 i.e., 5.0 pH recorded minimum alcohol content as 8.99 per cent.

In respect of different treatment combinations, S_2P_3 recorded significantly higher alcohol content with a reading of 9.81 per cent. This treatment combination was followed by treatment combination S_2P_2 i.e., 6 per cent *Saccharomyces cerevisiae* var. *ellipsoideus* inoculum with 3.5 pH, which recorded 9.54 per cent alcohol. It can be also observed that, treatment combination of *Saccharomyces cerevisiae* var. *ellipsoideus* inoculum at 3 per cent with 5.0 pH (S_1P_5) was associated with the minimum values of alcohol content as 8.79.

All the readings of alcohol content of wine of present investigation fall within the range of 8 to 15.5 per cent by volume as per Indian Standard Table Wines – Specification (BIS, 2005), and in the range of 7 to 16 per cent of the total volume of wine as stated by Vilanova *et al.* (2007) [19]. Similar findings regarding alcohol content of wine in the range of 6.6 to 11.53 per cent have been reported by different researchers as 11.53 per cent in bael wine by Chauhan *et al.* (2016) [5]; and 6.6 to 7.5 per cent in jamun wine by Gaikwad *et al.* (2016) [7].

The wines prepared from treatment combinations S_2P_3 and S_2P_2 can be considered superior in respect of various biochemical constituents as they had higher levels of alcohol content and most of the nutrients present in fruit juice of Nagpur mandarin, along with other compounds synthesised by the fermenting yeast, as stated by Bhutani *et al.* (1989) [3].

Titratable acidity

Table 3: Effect of different levels of yeast inoculum and pH on the acidity of wines

Acidity* (%)				
Treatment	**S_1**	**S_2**	**S_3**	**Mean**
P_1	1.21 (6.31)	1.21 (6.32)	1.23 (6.37)	1.22 (6.33)
P_2	0.94 (5.57)	0.93 (5.53)	0.94 (5.55)	0.94 (5.55)
P_3	0.76 (4.99)	0.76 (4.99)	0.77 (5.04)	0.76 (5.01)
P_4	0.64 (4.60)	0.65 (4.61)	0.64 (4.59)	0.64 (4.60)
P_5	0.53 (4.19)	0.54 (4.23)	0.54 (4.20)	0.54 (4.20)
Mean	0.82 (5.13)	0.82 (5.14)	0.82 (5.15)	
	S	P	S X P	
'F' test	NS	Sig	NS	
SE (m)±	0.020	0.026	0.046	
CD at 5%	-	0.076	-	

*as citric acid

(Figures in parentheses indicate arc sine transformed values)

In present investigation, the individual effect of different levels of yeast inoculum, and the interaction effect of different levels of yeast inoculum and pH of must on the acidity of Nagpur mandarin wine was non-significant. Whereas, effect of the different levels of pH of must on the acidity of the wines prepared from *mrig bahar* fruits of Nagpur mandarin was found to be significant.

Significantly higher acidity of wine (1.22%) was recorded in treatment P_1 (3.0 pH). On the other hand, the treatment P_5 (5.0 pH) recorded minimum acidity as 0.54 per cent. This difference in the acidity of wine amongst the various pH treatments is because of adjustment of pH of must at 3.0, 3.5, 4.0, 4.5, and 5.0 for treatment P_1, P_2, P_3, P_4, and P_5, respectively, as a part of experimental methodology, and as a general principle, the acidity of a solution is inversely proportional to its pH.

All the readings of acidityof wines of the treatments P_2 (i.e., 3.5 pH), P_3 (i.e., 4.0 pH), P_4 (i.e., 4.5 pH) and P_5 (i.e., 5.0 pH) fall in between 0.5 to 1.0%, which is considered as the suitable range for acidity of the wine, as reported by Snell and Ettre (1974) [18]. Contrarily, all the readings of acidity of the treatment P_1 (i.e., 3.0 pH) were more than 1.0%, suggesting that, wine prepared from treatment P_1 may not be preferred.

pH

The data presented in Table 4 is related with the effect of different levels of yeast inoculum and pH of must on pH of Nagpur mandarin wines.

Table 4: Effect of different levels of yeast inoculum and pH on the pH of wines

pH				
Treatment	**S_1**	**S_2**	**S_3**	**Mean**
P_1	2.82	2.81	2.75	2.79
P_2	3.27	3.30	3.24	3.27
P_3	3.83	3.75	3.74	3.77
P_4	4.21	4.21	4.28	4.23
P_5	4.75	4.71	4.79	4.75
Mean	3.77	3.76	3.76	
	S	P	S X P	
'F' test	NS	Sig	NS	
SE (m)±	0.025	0.032	0.056	
CD at 5%	-	0.093	-	

Based on data available, it can be observed that, pH of must significantly affected the pH of the wine, whereas, the individual effect of yeast inoculum on pH of wine as well as interaction effect of yeast inoculum and pH of must on pH of wine was non-significant.

A perusal of the data of pH of wines reveals that, there was a significant gradual increase in pH of wine from treatment P_1 to P_5. This significant gradual increase in the pH of wine amongst various pH treatments is because of adjustment of pH of must at 3.0, 3.5, 4.0, 4.5, and 5.0 for treatment P_1, P_2, P_3, P_4, and P_5, respectively, as a part of experimental methodology, which has been ultimately reflected in the wines prepared with these specific pH treatments.

Residual sugars

The residual sugar content of wine depends upon the initial sugar content of must and the degree of fermentation. Thus, a wine having minimum residual sugars might have a history of higher degrees of fermentation, and vice-versa.

Table 5: Effect of different levels of yeast inoculum and pH on the residual sugars of wines

Residual sugars (%)				
Treatment	**S_1**	**S_2**	**S_3**	**Mean**
P_1	3.57 (10.89)	2.66 (9.38)	2.58 (9.24)	2.94 (9.84)
P_2	3.08 (10.11)	2.44 (8.96)	3.17 (10.25)	2.90 (9.77)
P_3	3.20 (10.30)	1.91 (7.93)	2.82 (9.67)	2.64 (9.30)
P_4	2.80 (9.64)	2.55 (9.19)	2.65 (9.35)	2.67 (9.39)
P_5	3.76 (11.18)	3.65 (11.02)	2.93 (9.85)	3.45 (10.68)
Mean	3.28 (10.42)	2.64 (9.30)	2.83 (9.67)	
	S	P	S X P	
'F' test	Sig	Sig	Sig	
SE (m)±	0.087	0.112	0.194	
CD at 5%	0.251	0.324	0.562	

(Figures in parentheses indicate arc sine transformed values)

From the data of this trial, it can be observed that, minimum readings for residual sugars as 2.64 per cent was associated with S_2 i.e., 6 per cent yeast inoculum level. Whereas, in respect of different pH levels, treatment P_3 i.e., 4.0 pH recorded minimum residual sugars of wine (2.64%) which was at par with P_4 i.e., 4.5 pH (2.67%). As a function of interaction of different levels of yeast inoculum and pH, significantly lower value for residual sugars (1.91%) was recorded by S_2P_3 i.e., the treatment combination of 6 per cent wine yeast inoculum with 4.0 pH.

Thus, on the basis of significantly lower residual sugars content of wine, treatments S_2 (6% inoculum of *Saccharomyces cerevisiae* var. *ellipsoideus*), and P_3 (4.0 pH); and treatment combination S_2P_3 (6% inoculum of *Saccharomyces cerevisiae* var. *ellipsoideus* with 4.0 pH) can be considered superior which might have undergone higher degrees of fermentation.

Volatile acidity

According to Henick-Kling (1995) [8], the presence of volatile acids in very small quantity is inevitable in the final matured wines and this does not necessarily mean that, they indicate at the beginning of deterioration.

Table 6: Effect of different levels of yeast inoculum and pH on the volatile acidity of wines

Volatile acidity** (%)				
Treatment	**S_1**	**S_2**	**S_3**	**Mean**
P_1	0.018	0.016	0.019	0.018
P_2	0.017	0.020	0.024	0.020
P_3	0.024	0.022	0.025	0.024
P_4	0.025	0.025	0.024	0.025
P_5	0.026	0.024	0.025	0.025
Mean	0.022	0.021	0.023	
	S	P	S X P	
'F' test	Sig	Sig	Sig	
SE (m)±	0.000	0.001	0.001	
CD at 5%	0.001	0.002	0.003	

**as acetic acid

In respect of individual effect of yeast inoculum on volatile acidity of wine, significantly lower reading as 0.021 per cent was recorded for treatment S_2 (i.e. 6% yeast inoculum). Similarly, in respect of effect of pH of must on volatile acidity of wine, minimum volatile acidity of wine was recorded in treatment P_1 i.e., 3.0 pH (0.018%), wherein treatment P_2 i.e., 3.5 pH was at par with P_1 with volatile acidity 0.020 per cent.

During this investigation, treatment combination S_2P_1 had minimum reading for volatile acidity (0.016%) amongst all other treatment combinations.

All the readings of volatile acidity of wine in the present investigation are lower than the maximum permissible limit as per Indian Standard Table Wines – Specification (i.e., 1 gL^{-1} equivalent to 0.1%) for dry as well as sweet table wines (BIS, 2005) [4].

Ascorbic acid

The data of ascorbic acid content of Nagpur mandarin wine, as influenced by different levels of wine yeast inoculum of *Saccharomyces cerevisiae* var. *ellipsoideus* and pH of must is presented in Table 7.

Table 7: Effect of different levels of yeast inoculum and pH on the ascorbic acid of wines

Ascorbic acid (mg 100 mL^{-1})				
Treatment	**S_1**	**S_2**	**S_3**	**Mean**
P_1	27.78	28.81	29.51	28.70
P_2	28.51	29.41	30.09	29.34
P_3	27.98	29.40	30.52	29.30
P_4	28.23	29.05	30.62	29.30
P_5	28.38	28.87	30.33	29.19
Mean	28.28	29.11	30.21	
	S	P	S X P	
'F' test	Sig	NS	NS	
SE (m)±	0.554	0.716	1.240	
CD at 5%	1.601	-	-	

A perusal of the data presented reveals that the effect of different levels of *Saccharomyces cerevisiae* var. *ellipsoideus* on ascorbic acid content of wine was significant. In this, maximum ascorbic acid content as 30.21 mg 100 mL^{-1} was recorded in treatment S_3. On the other hand, effect of different levels pH of must, as well as interaction effect of different levels of *Saccharomyces cerevisiae* var. *ellipsoideus* and pH of must, on ascorbic acid content of wine was non-significant.

Non-enzymatic browning

From the data of non-enzymatic browning (NEB) presented in Table 8, it can be observed that effect of different levels of yeast inoculum and pH of must, independently as well as in combination, had significant effect on non-enzymatic browning of wines prepared from *mrig bahar* fruits of Nagpur mandarin.

Table 8: Effect of different levels of yeast inoculum and pH on non-enzymatic browning of wines

Non-enzymatic browning				
Treatment	**S_1**	**S_2**	**S_3**	**Mean**
P_1	0.014	0.014	0.015	0.015
P_2	0.017	0.013	0.016	0.015
P_3	0.015	0.014	0.014	0.014
P_4	0.016	0.015	0.020	0.017
P_5	0.017	0.016	0.016	0.016
Mean	0.016	0.015	0.016	
	S	P	S X P	
'F' test	Sig	Sig	Sig	
SE (m)±	0.000	0.000	0.001	
CD at 5%	0.001	0.001	0.001	

All the readings of NEB of wines were within the range of 0.013 to 0.020, as measured by optical density of wine samples at 440nm. These variations in NEB of different wine samples might be due to the differences in rate of ascorbic acid degradation, caramelization (degradation of sugars), and the Maillard reaction (sugar-amino acid reaction) in these wine samples, which resulted in non-enzymatic browning (Rufian-Henares *et al.*, 2009) [16].

Conclusion

Storage studies of wines prepared from *Mrig Bahar* fruits of Nagpur mandarin, using various treatment combinations of different levels of wine yeast inoculum and pH of must revealed that, various biochemical parameters of wines were influenced by these two factors individually as well as in combination. On the basis of findings of present investigation and specifications suggested for different chemical constituents of Indian standard wine, it can be said that a standard quality wine with higher alcohol content can be prepared from *Mrig Bahar* fruits of Nagpur mandarin by using two treatment combinations: first, 6 per cent inoculum of *Saccharomyces cerevisiae* var. *ellipsoideus* with 4.0 pH of must; and the second, 6 per cent inoculum of *Saccharomyces cerevisiae* var. *ellipsoidus* with 3.5 pH of must.

References

1. Amerine MA, Berg HW, Kunkee RE, Ough CS, Singleton VL, Webb AD. The Technology of Wine Making, (4th Edn.) AVI Publ. Co., Westport, Connecticut, 1980, 794.
2. Bhatnagar P, Singh J, Jain MC, Singh B, Manmohan JR, Dashora LK. Studies on seasonal variations in developing fruits of Nagpur mandarin (*Citrus reticulata* Blanco) under Jhalawar conditions. The Asian J Hort 2012;7(2):263-265.
3. Bhutani VP, Joshi VK, Chopra SK. Mineral composition of experimental wines. Indian Food Packer 1989;26(2):332-333.
4. BIS, Indian Standard Table Wines - Specification (Second Revision), IS 7058:2005, Bureau of Indian Standards, New Delhi, India 2005.
5. Chauhan, Harmeet, Kaul, Raj Kumari, Ahmed, Naseer, Gupta, Prerna *et al*. Development and evaluation of Bael (*Aegle marmelos*) wine. Environment and Ecology 2016;34(4D):2611-2616.
6. FSSAI, Lab Manual 13, Manual of Methods of Analysis of Foods: Alcoholic Beverages, Ministry of Health and Family Welfare (GOI), N. Delhi 2015, 3-4.
7. Gaikwad RS, Thorat SS, Kotecha PM. Preparation of wine from Jamun fruits (*Syzygium cumini* L). Bioinfolet - A Quarterly Journal of Life Sciences 2016;13(2b):332-335.
8. Henick-Kling T. Control of malo-lactic fermentation in wine: Energetics, flavour modification and methods of starter culture preparation. J Appl. Bacteriol. Symp. Suppl 1995;79:29S-37S.
9. Honde VM, Adsule RN. Effect of inoculums levels on the chemical composition and sensory properties of sapota wine. J. Maharashtra Agric. Univ 1998;23(1):89-90.
10. Khandelwal P, Kumar V, Das N, Tyagi SM. Development of a process for preparation of pure & blended Kinnow wine without debittering Kinnow mandarin juice. Internet Journal of Food Safety 2006;8:24-29.
11. Kumar YS, Prakasam RS, Reddy OVS. Optimisation of fermentation conditions for mango (*Mangifera indica* L.) wine production by employing response surface methodology. Intl. J Food Sci. Technol 2009;44:2320-2327.
12. Mathewson SW. The manual for the home and farm production of alcohol fuel. Ten Speed Press 1980.
13. Mazumdar BC, Majumdar K. Method on Physico-chemical Analysis of Fruits. Daya Publishing House, 2003, 112-125.
14. Morton JF. Mandarin, Fruits of Warm Climates. Miami, FL 1987.
15. Ranganna S. Handbook of Analysis and Quality Control for Fruit and Vegetable Products (2nd Edn.), Tata McGraw-Hill Publ. Co. Ltd., New Delhi 2000, 1112.
16. Rufian-Henares JA, Andrade CD, Morales FJ. Non-Enzymatic Browning: The Case of the Maillard Reaction. In: Delgado-Andrade, C. and Rufian-Henares, J.A. (Eds.), Assessing the Generation and Bioactivity of Neo-Formed Compounds in Thermally Treated Foods, Editorial Atrio, Granada 2009, 5-32.
17. Sadasivam S, Manickam A. Biochemical Methods for Agricultural Sciences, Willey Eastern Ltd 1996.
18. Snell FD, Ettre ISL. Wine and Must. In: Encyclopaedia of Industrial Chemical Analysis. Interscience Publishers. John Wiley and Sons. Inc. New York 1974;14:632.
19. Vilanova M, Cortes S, Santiago J, Carmen LM, Esperanza F. Aromatic compounds in wines produced during fermentation: Effect of three red cultivars. Intl. J Food Properties 2007;10(4):867-875.
20. Watson F. Aromatherapy Blends and Remedies. Thorsons, An imprint of Harper Collins Publishers, San Francisco, CA 1994, 270.