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Influence of sugar sources and blended must on physico-chemical and sensory characteristics of Nagpur mandarin wine

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Abstract
An investigation on "Effect of different sugar sources and blended must on physico-chemical and sensory characteristics of Nagpur mandarin wine" was conducted at Post-Harvest Technology Laboratory, Department of Fruit Science, Dr. PDKV, Akola during the academic year 2017-18 with the objectives of to study the chemical changes and sensory qualities of blended wine prepared from Nagpur mandarin and to find out the suitable combinations of sugar sources and blended wine prepared from Nagpur mandarin. The experiment was carried out with three sugar sources (Cane sugar, Jaggery and Honey) and Nagpur mandarin juice was blended with coloured grape and pomegranate juices in different proportion and framed in Factorial Completely Randomized Design with three replications and fifteenth treatments. The wine of each bottle was transferred into 200 ml fresh sterile glass bottles and sealed air-tight with crown caps, keeping 0.7 cm head-space. The sealed wine bottles were subjected for pasteurization in water bath at 65 °C for 20 minutes. After cooling, the wine bottles were labeled with respective treatment name and left for storage of 3 months. From the finding it was observed that, there was decrease in ethyl alcohol, TSS and total phenol content of Nagpur mandarin wine irrespective of storage period. Whereas, pH content of Nagpur mandarin wine increased with the advancement of storage period of 3 months. Maximum ethyl alcohol, pH and total phenol and minimum TSS was observed when Nagpur mandarin wine prepared with Honey as sugar source and blended with mandarin juice and coloured grape juice with 80:20 ratio. Similarly, the Nagpur mandarin wine prepared with Honey as sugar source and blended with mandarin juice and coloured grape juice with 80:20 ratio secured the highest score for colour, flavour, taste, appearance, astringency and overall acceptability as compared to other treatment.

Keywords: Nagpur mandarin, wine, sugar sources, blending, physico-chemical and sensory evaluation

Introduction
Citrus is one of the leading fruit crops of the world and adaptable to wide range of soil, terrain, planting and cultural arrangements. It is widely grown in most areas with suitable climates tropical, subtropical and borderline subtropical and temperate (Kahn *et al.*, 2001) [10]. The citrus growing state in India are Maharashtra, Madhya Pradesh, Andhra Pradesh, Telgana, Punjab, Karnataka, Orissa, Bihar, Haryana, Assam, Tamil Nadu, Gujarat, etc. The area, production and productivity of citrus in India during 2018-19 was 1003 thousand ha and 12546 thousand MT and 12.0 MT/ha, respectively (Anon, 2019) [1].

Nagpur santra is the only cultivar of mandarin grown in Vidarbha for last 200 years, on around 100.7 thousand ha area. Cultivation of Nagpur mandarin is mostly concentrated in Amravati, Nagpur, Wardha, Yaotmal, Akola, Washim and Buldana districts of Vidarbha region, which comprises of about 75 per cent area under mandarin cultivation in Maharashtra.

Citrus fruit juices in general and mandarin juices in particular have a poor shelf-life and face problems of post-harvest losses. Mandarin can be consume fresh or processed for preparation of juice concentrate, crush, squash, syrup, jam, marmalade, etc. Apart from these products, mandarin can also be utilized for preparation of wine, which can be a potential value addition step to this fruit crop. A typical wine contains ethyl alcohol, sugars, acids, higher alcohol, tannins, aldehydes, esters, amino-acid, minerals, vitamins, anthocyanin and minor constituents like flavouring compounds, etc. (Amerine *et al.*, 1980) [2]. The utilization of Nagpur mandarin for preparation of wine can solve the problems of market surplus and related spoilage, apart from development of a new type of wine.

Material and Methods

Fruits of Nagpur mandarin, coloured grape and pomegranate were obtained from Local Fruit Market, Akola. The well mature, healthy fruits were carefully graded and brought to the laboratory for further experimentation. The selected fruits were thoroughly washed with clean tap water to remove dirt and dust particles adhered to the pericarp of the fruits (Singh and Kumar, 1995) [16]. The yeast strain of *Saccharomyces cerevisiae* var. *ellipsoideus* was used for the present study.

Preparation and storage of wine

The juice of selected fruits of Nagpur mandarin, coloured grape and pomegranate were extracted seperatly with the help of screw type juice extractor and then strained through muscline cloth to separate seeds and fiber. The above extracted juices were used for the preparation of blended must. Initially, the mandarin juice was measured in different reagent bottles and then different blending (Factor 'B') was given as per the treatment details. The TSS of blended juice was raised by addition of sugar sources *viz*., cane sugar, jaggery and honey at 24 ºBrix. Sodium benzoate was added to the juice at the rate of 150 ppm to inhibit the wild yeast and other spoilage microorganism and leave for four hours. After four hours the must was supplemented with 0.1% diammonium hydrogen phosphate (DAHP). Then an active yeast culture was added to each treatment at the rate of 5% to the reagent bottles containing must of different treatment. The must was allowed to ferment with air lock assembly 'on' to create anaerobic condition. An experiment was conducted in Factorial Completely Randomized Design comprise fifteenth different treatments and replicated thrice.

After completion of fermentation, the yeast and other material settled down at the bottom of the reagent bottle leaving clear wine as supernatant. The supernatant wine was then siphoned off to new sterilized bottles using a rubber tubing to separate the lees. After siphoning, the wine was clarified with the aid of 0.4 g l^{-1} bentonite to recover wine of crystal clear quality finish. The wine was clarified by decantation for two times after a sedimentation period of 7 days each in order to get clear wine. Then the wine of each bottle was transferred into 200 ml fresh sterile glass bottles and sealed air-tight with crown caps, keeping 0.7 cm head-space. The sealed wine bottles were subjected for pasteurization in water bath at 65 °C for 20 minutes. After cooling, the wine bottles were labeled with respective treatment name and left for storage of 3 months.

Physico-chemical and sensory evaluation

Wines from different treatment combinations were analyzed for various physic- chemical parameters and sensory evaluation at fresh and 3 months. The ethyl alcohol content of wine samples was estimated pycnometer method (FSSAI, 2015) [5]. The pH of wine was measured by using Perkin Elmer pH meter at 30 ºC temperature. Total soluble solids (ºB) were determined with the help of digital refractometer and values are corrected to 20 ºC with the help of temperature correction chart (AOAC, 1995) [3]. The total phenols content of Nagpur mandarin wine was estimated by using the method described by Mazumdar and Majumdar (2003) [13]. Sensory analysis was done by 5 trained panelist who gave score for various parameters like colour, flavour, taste, appearance, astringency and overall acceptability on a 9 point hedonic scale.

Statistical analysis

The data collected on various observations, during the course of investigation were statistically analyzed by Factorial Completely Randomized Design as suggested by Panse and Sukhatme (1985) [14].

Results and Discussion

Physico-chemical analysis of wine

The data related to physico-chemical characteristics of Nagpur mandarin wine at fresh and 3 months of storage are presented in Table 1. It is evident from the statistical analysis of the data that with advancement in storage period, a slight decrease was observed in all the parameters except pH.

Ethyl alcohol

Significantly maximum ethyl alcohol content (11.85 and 11.79%) was observed in treatment combination S_3B_2 (Honey blend with 80:20- mandarin juice: coloured grape juice) for fresh and 3 months aged Nagpur mandarin wine, respectively. Whereas, the treatment combination S_2B_5 (Jaggery with 100% mandarin juice) was observed minimum ethyl alcohol content (10.39 and 10.39%) for fresh and 3 months, respectively. A decrease in ethyl alcohol content during storage is apparently the result of interaction between alcohols and acids to form esters (Amerine *et al.*, 1980 and Zoecklein *et al.*, 1995) [2, 22]. It is desirable as total ester formation results in higher fruity flavour in wine. The results obtained in the present investigation are in close agreement with the findings of Sharma and Joshi (2003) [17] in strawberry wine, Ghan Shyam (2009) [6] in wild apricot sugar base wine and mead, Joshi *et al*. (2012) [9] in jamun wine and Kumar *et al*., (2016) [11] in custard apple wine.

pH

Significantly maximum pH for fresh and 3 months aged Nagpur mandarin wine was reported as 3.95 and 4.06, respectively in treatment combination S_3B_2 (Honey with 80:20- mandarin juice: coloured grape juice). Whereas, minimum pH content for fresh and 3 months aged Nagpur mandarin wine was reported as 3.45 and 3.54, respectively in treatment combination S_2B_5 (Jaggery with 100% mandarin juice). The increase in pH of Nagpur mandarin wine during storage period might be due to the balancing of organic sources of nitrogen such as hydrolysed protein which might cause the pH to drift towards the alkaline or acidic side (Ward, 1989) [20]. Similar results have been reported by Sharma and Joshi (2003) [17] in strawberry wine, Kumar *et al*. (2016) [11] in custard apple wine reported changes in pH which seems to increase with advancement of maturation time, Lokesh *et al*. (2014) [12] in jamun wine.

TSS

Significantly minimum TSS content (7.90 and 7.70 ºB) was observed in treatment combination S_3B_2 (Honey with 80:20- mandarin juice: coloured grape juice) for fresh and 3 months aged Nagpur mandarin wine, respectively. Whereas, maximum TSS content (10.80 and 10.60 ºB) was observed in treatment combination S_2B_5 (Jaggery with 100% mandarin juice) for fresh and 3 months aged Nagpur mandarin wine, respectively. The decrease in total soluble solids of Nagpur mandarin wine during aging period might be due to precipitation of soluble solids during interaction of various components which might have resulted in decrease in total soluble solids during maturation (Joshi *et al*., 1999) [7]. The results are in conformity with the findings of various research workers Sharma and Joshi (2003) [17] in strawberry wine, Veena (2015) [19] in blended grape wine, Joshi *et al*. (2012) [9]

in jamun wine and Joshi *et al*. (2014) [8] observed in mandarin orange wine that during maturation, there was decreasing trend in TSS of wine.

Total phenols

Significantly maximum total phenols content (94.43 and 94.34 mg 100 ml^{-1}) was observed in treatment combination S_3B_2 (Honey blended with 80:20- mandarin juice: coloured grape juice) for fresh and 3 months aged Nagpur mandarin wine, respectively. Whereas, minimum total phenols content (92.29 and 92.16 mg 100 ml^{-1}) was observed in treatment combination S_2B_5 (Jaggery with 100% mandarin juice) for fresh and 3 months aged Nagpur mandarin wine, respectively. Decrease in phenols concentration might be due to the susceptibility of phenolic constituents to degradation, condensation and polymerization, and subsequent precipitation (Beridze, 1948; Somers, 1987; Zoecklein *et al*., 1995) [4, 18, 22]. The decrease in total phenols is desirable as after their polymerization, palatability of the wine increases (Sharma and Joshi, 2003) [17]. The result of the present investigation was supported by the findings of Kumar *et al*. (2016) [11] custard apple wine, Reddy *et al.* (2017) [15] in blended aonla wine and Yadav and Jain (2019) [21] in mandarin wine.

Table 1: Interaction effect of sugar sources and blended must on ethyl alcohol, pH, total soluble solids and total phenols of Nagpur mandarin wine during storage

Treatments	Ethyl alcohol (%)		pH		TSS (°B)		Total Phenols (mg 100 ml^{-1})	
	Fresh	3 Months	Fresh	3 Months	Fresh	3 Months	Fresh	3 Months
S_1B_1	11.26	11.23	3.76	3.88	8.80	8.50	93.80	93.71
S_1B_2	11.59	11.51	3.83	3.95	8.70	8.60	94.01	93.89
S_1B_3	10.92	10.87	3.63	3.74	8.60	8.60	93.05	92.96
S_1B_4	10.64	10.70	3.66	3.75	9.00	8.90	93.18	93.06
S_1B_5	10.59	10.53	3.50	3.59	10.50	10.40	92.43	92.32
S_2B_1	11.43	11.40	3.72	3.83	8.60	8.40	93.50	93.38
S_2B_2	11.26	11.26	3.79	3.89	8.70	8.70	93.65	93.52
S_2B_3	10.81	10.78	3.57	3.66	9.40	9.30	92.69	92.58
S_2B_4	10.51	10.50	3.60	3.70	10.10	10.10	92.90	92.79
S_2B_5	10.39	10.39	3.45	3.54	10.80	10.60	92.29	92.16
S_3B_1	11.59	11.54	3.88	3.98	8.50	8.30	94.21	94.10
S_3B_2	11.85	11.79	3.95	4.06	7.90	7.70	94.43	94.34
S_3B_3	11.37	11.34	3.70	3.82	9.50	9.50	93.30	93.18
S_3B_4	11.12	11.09	3.78	3.89	9.60	9.70	93.42	93.30
S_3B_5	10.45	10.56	3.53	3.63	9.90	9.90	92.55	92.43
F Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m)±	0.034	0.032	0.013	0.014	0.165	0.132	0.020	0.018
CD at 5%	0.097	0.093	0.039	0.041	0.478	0.380	0.057	0.053

Sensory evaluation

The data pertaining to sensory evaluation are presented in Table 2 (a) and (b). From the result it was revealed that, there was increase in sensory score among all the treatments during fresh to 3 months of storage period of Nagpur mandarin wine. The blended wine prepared from Nagpur mandarin evaluated for different sensory attributes *viz.*, colour, flavour, taste, appearance, astringency and overall acceptability. The scores were used to evaluate the overall quality of wine. The wine prepared from the Honey blended with 80:20- mandarin juice: coloured grape juice (S_3B_2) secured the highest score among the different treatment.

Table 2(a): Effect of sugar sources and blended must on colour, flavour and taste score of Nagpur mandarin wine during storage

Treatments	Colour		Flavour		Taste	
	Fresh	3 months	Fresh	3 months	Fresh	3 months
S_1B_1	6.6	6.8	6.4	6.8	6.4	6.6
S_1B_2	6.8	7.2	6.4	6.6	6.8	6.8
S_1B_3	6.4	6.6	6.8	7.0	6.4	6.6
S_1B_4	6.6	7.2	6.6	6.8	7.0	6.8
S_1B_5	6.4	6.8	6.4	6.8	5.8	5.8
S_2B_1	7.0	7.2	7.0	7.2	6.2	6.2
S_2B_2	7.2	7.2	7.0	6.8	7.0	6.8
S_2B_3	7.0	7.4	6.4	7.0	6.8	6.8
S_2B_4	7.2	7.4	6.4	6.6	6.4	6.8
S_2B_5	6.8	7.0	6.2	6.4	6.0	6.4
S_3B_1	7.0	7.2	6.8	6.8	7.0	7.0
S_3B_2	7.4	7.6	7.4	7.6	7.2	7.4
S_3B_3	6.8	7.0	7.2	7.4	6.2	6.4
S_3B_4	6.6	7.2	6.8	6.8	6.4	6.6
S_3B_5	7.0	6.8	7.0	6.8	6.8	6.8

Table 2(b): Effect of sugar sources and blended must on appearance, astringency and overall acceptability score of Nagpur mandarin wine during storage

Treatments	Appearance		Astringency		Overall acceptability	
	Fresh	3 months	Fresh	3 months	Fresh	3 months
S_1B_1	6.2	6.2	6.4	6.8	7.2	7.6
S_1B_2	6.2	6.4	6.4	6.6	7.4	7.4
S_1B_3	6.0	6.2	7.0	6.8	6.4	6.6
S_1B_4	6.2	6.2	6.6	6.8	7.0	7.4
S_1B_5	5.8	6.2	6.0	6.2	6.4	6.6
S_2B_1	6.4	6.6	7.0	7.2	7.0	7.4
S_2B_2	6.8	6.8	7.4	7.6	6.8	7.0
S_2B_3	6.4	7.0	7.2	7.4	6.4	6.8
S_2B_4	6.4	6.8	7.0	7.2	6.4	6.6
S_2B_5	6.2	6.4	6.4	6.6	6.2	6.2
S_3B_1	7.0	7.2	6.2	6.2	7.8	8.0
S_3B_2	7.6	7.8	7.2	7.4	8.0	8.2
S_3B_3	7.0	6.8	6.8	7.0	6.6	6.8
S_3B_4	6.8	6.8	7.0	6.8	6.4	6.8
S_3B_5	6.8	6.8	6.6	6.8	6.8	7.0

Conclusion

Among the different sugar sources Honey and blending ratios, 80:20 (mandarin juice: coloured grape juice) ratio was found superior regarding ethyl alcohol, pH, total soluble solids and total phenol content at fresh and 3 months storage Nagpur mandarin wine. The Nagpur mandarin wine prepared with Honey as sugar source and blended with mandarin juice and coloured grape juice with 80:20 ratio secured the highest score for colour, flavour, taste, appearance, astringency and overall acceptability as compared to other treatment. From the overall assessment of results obtained, it can be concluded that the blending of mandarin and coloured grape juice in the ratio of 80:20 along with Honey as a sugar source was found suitable for preparation of Nagpur mandarin wine.

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