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Preparation and Quality Analysis of Wine from Different Blends of Carrot-Beetroot and Carrot-Orange

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One of the most popular alcoholic beverages that offers several health benefits is wine. It includes both fruit and vegetable wine and sometimes their blends. These pure and coproducts of fruits and vegetables give surprising results when tried. Beetroot (Beta vulgaris L.) and carrot (Daucus carota L.) are high in betalain and carotene, both of which have medicinal and nutritional properties. Apart from beetroot and carrot, another important fruit is orange (Citrus sinensis). It is a notable fruit known for its nourishing and restorative attributes. The fruits and vegetables used in this study (beetroot, carrot, and orange) were cleaned, peeled, and crushed to extract the juice. The juice was then fermented by mixing with yeast (Saccharomyces cerevisiae) and other ingredients such as sugar. Once fermentation was complete, various methods are used for analysis of wine like residual sugar (RS), apparent fermentation degree (AFD), fermentative capacity (FC), fermentative velocity (VC), and attenuation, etc. The vegetable-fermented wine obtained was reddish to yellow in colour, had a titratable acidity of 1.0 ±0.02 g tartaric corrosive/100 mL, was dry (with just the right amount of piece sugar), and contained between 10 and 12% alcohol. There were no discernible variations in the wine's biological components. An organoleptic analysis of the vegetable natural product wine revealed that it was palatable and thought to be reasonable for health.

Keywords: Alcohol; Beetroot; Carrot; Orange; Saccharomyces cerevisiae; wine.

The medicinal property of fruits and vegetables is contributed by the essential vitamins, minerals, and phytochemicals present in them. Beetroot, carrot, and oranges are generally accessible vegetables and natural products[1]. The medicinal properties of these vegetable and fruit plants and their products are utilized since ancient times in various forms, beneficial to human beings, and can also be used for preparation of wine. Beetroot is supplement rich and contains betalains, amino mixtures like taurine, minerals and nutrients[2]. The red shade of beetroot is due to betalains[3] which are good for heart and have cell reinforcement properties[4]. Medicinal properties of betalains also help in regulating hypertension[5]. The strong health-promoting characteristics of carrots make them valuable root vegetables. They are also a rich source of bioactive chemicals and dietary fiber. Due to the presence of high antioxidants and anticancer activities, the utilization of carrots is expanding at a consistent rate. Carrot pomace containing around half of â-carotene could

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productively be used for the supplementation of items like cake, bread, rolls, and preparation of a few kinds of practical items. Carrots get their orange colour from beta-carotene, a precursor of Vitamin A. Additionally, they are rich in minerals, fiber, and cancer-prevention compounds, carrots are also believed to have anthelmintic, carminative, preventive, galactagogue, ophthalmic, and antioxidant properties[6]. Due to its overall phenolic content of 50–60 mol/g dry weight, beetroot is in the top ten most remarkable vegetables in terms of its capacity to promote cell growth[7, 8]. The betalains (comprising red betacyanins and yellow betaxanthins) present in beetroot neutralize free radicals and stop biological molecules from oxidizing. Therefore, betalains have been broadly utilized in the cutting-edge food industry. The third significant fruit part in the current investigation was orange. Oranges have significant antibacterial, antifungal, cardio-defensive, antioxidant, and anti-hypertensive effects. Limonene, citral, neohesperidin, naringin, rutin, rhamnose, eriocitrin, and L-ascorbic acid are all present in the complete plant's phytochemical makeup. Fruits and vegetables are a prospective supply of important compounds including phytochemicals (carotenoids, phenolics, and flavonoids), antioxidants, antimicrobials, and minerals, which offer fantastic novel exercises or beneficial benefits. Jagtap and Bapat (2015), studied the production of a wide range of fruit, including apple, papaya, mango, guava, etc.[9]. They depicted that fruit wines are often high in antioxidants and other beneficial compounds and may have potential as functional foods. Garg (2017) discusses a wide variety of fruit and vegetable wines that are produced around the world. These include traditional wines made from mahua, honey, rhododendron, sweet potato, tomato, whey, and cocoa. They observed that fruit and vegetable wines have the potential to be used as functional foods, which can provide health benefits beyond basic nutrition. The authors suggest that these wines could be fortified with specific bioactive compounds, such as polyphenols and flavonoids, which have been shown to have powerful antioxidant and anti-inflammatory effects. In the present study, we have tried to evaluate wine from beetroot-carrot blend and carrot-orange blends. Wine from fruits and vegetable blends was prepared and analyzed for its biochemical and physiochemical properties. This work was carried out for standardization of technology of wine preparation from different blends of carrot-beetroot and carrot-orange. The current research was conducted to explore the nutritional aspects of carrot, beetroot and orange. These substrates can be converted into stable products like wine which can be stored for long time and consumers can get their benefits in off season. Such type of value addition can help in increasing its market opportunities and economic value.

MATERIALS AND METHODS

The present project work entitled, "Preparation and quality analysis of wine from different blends of carrot-beetroot and carrot-orange" was carried out in Department of Biotechnology, Government College, Hisar.

Substrate

The fresh and ripened fruits of orange and vegetables (carrot and beetroot) were acquired from the neighborhood market of Hisar (Haryana) and were utilized for the readiness of wine.

Yeast used and inoculum preparation

Pure *Saccharomyces cerevisiae* strain cultures were obtained from the Biotechnology lab of Government College, Hisar. The cultures were maintained on YEPD medium (yeast culture). For preparation of yeast (*S. cerevisiae*) inoculum, sterilized grape juice was used. A loopful of 24 hrs. old yeast grown on agar slant was transferred aseptically to 10 ml of grape juice and allowed to grow for 24 hrs at 30°C. The whole contents of the tube were transferred to 100 ml of sterilized grape juice and incubated at 30°C/24 hrs under mild shaking conditions and were used as inoculum for wine production.

Extraction of juice from carrot, beetroot, and orange

Fruits and vegetables that had reached full ripeness were thoroughly washed with running water, and the mash (pulp) was separated physically from the seeds. The liquid was then manually squeezed through muslin fabric after the mash had been finely crushed in a blender.

Preparation of wine from carrot, beetroot, and orange fruit

Juice was blended in different ratios for

winemaking. An 8% starter culture of *S. cerevisiae* was added to a mixture of carrot and sugarbeet juice that contained 1 kg of carrot juice and 5% beetroot juice. Fermentation was placed in flasks at 25°C with the initial brix varied to 18, 20, and 22°brix. For chemical analysis, samples were taken at regular intervals. Observations persisted till decline in °Brix persisted. The wine was then clarified by freezing for 5 days after that wine was bottled and stored at refrigerated temperature. Blended juice was used for winemaking as per procedure described by Vivek and Debjani (2011)[11] with some modifications.

Maturation of wine

Maturation of clarified wine was done at refrigerated temperature for two months.

Analysis of wine

The wine was analyzed during storage period and biochemical changes were recorded at different time intervals. In a measuring cylinder with 50 ml of sample, the specific gravity of wine samples was calculated using a hydrometer (with the proper temperature correlation factor) (20°C). Calculations for residual sugar (RS), apparent fermentation degree (AFD), fermentative capacity (FC), fermentative velocity (VC), and attenuation were then made using the specific gravity values that had been acquired. Fresh wine prepared from different blends was analyzed by using following physicochemical characteristics. A method developed by Caputi and coworkers was used to estimate the percentage of ethanol in the samples[12]. A procedure developed by Amerine and coworkers was used to calculate the titrable acidity or percent acidity[13]. Iodine titration was used to evaluate the vitamin C level. Reducing sugars were calculated using the technique described by Miller[14]. A modified version of Blois's 2,2-diphenyl-1-picrylhydrazyl (DPPH) technique was used to assess the free radical scavenging activity[15]. By measuring the absorbance at various wavelengths, the hue and intensity of wine colour were determined spectroscopically. Organoleptic evaluation of the cider was based on its colour, general look, flavour, texture, and overall acceptability by a panel of judges. Also, the "Hedonic scale," a nine-point scale, was employed to assess customer approval[13].

RESULTS AND DISCUSSION

The current study's objective was to investigate how fruit veggie wine is produced and analyzed. Different wines were prepared using different blends of fruits and vegetables. Since most fruit juices and pulp naturally have less sugar than is ideal for making wine, it is usual practice to improve sugar content of juice with sucrose. Suresh and coworker reported that grape must be adjusted to 22°Brix with cane sugar[16]. In contrast, during fermentation of carrot juice, Lingappa and Naik reported substantially lower T.S.S. (18°Brix)[17]. The orange juice was adjusted to 23°Brix TSS with sucrose and glucose and fructose before fermentation[18]. First three blends of wine have same composition of carrot and beetroot with different brix. Brix for blend 1 (named AR1) is 18, and then it was increased up to 20 and 22 for the blend AR2 and AR3, respectively. On the other hand, blends AR4, AR5, and AR6 have different ratio of carrot and orange with same brix (22°Brix) in all blends. Pure carrot and pure orange juice was also used for fermentation with 22°Brix (Table 1).

Yeast culture was added to the prepared mashes at a rate of 1g/liter (Fig 1). Prescott and Dunn observed that the ideal inoculum level to produce wine ranges from 4-6%[19]. To reduce the likelihood of fermentation media contamination, Sterehaina and coworkers proposed that an inoculum concentration of 10.0% (v/v) is adequate for industrial fermentation[20]. The pH and acidity of the mashes that were produced were designed to inhibit the development of undesirable microflora in the fermentation media. Before fermentation, less acidic fruit juices or pulp must be acidified for wine manufacture. Lingappa and Naik have reported that total acidity of carrot juice should be adjusted to 0.9% using tartaric acid before fermentation[17]. At a pH of 4.5, Singh and coworkers found that kinnow wine had the highest ethanol level[21]. Lingappa and Naik adjusted the total titrable acidity of carrot juice to 0.9% by addition of tartaric acid[22]. Patil and Patil as well as Suryawanshi coworkers adjusted the acidity of orange juice to 0.7% with acid or alkali for wine preparation[23, 18]. Vivek and Debjani extracted the vegetable material and then combine the must. To achieve a pH of

4.5, cane sugar (250g) and citric acid were added to the juice[11]. Ifie and his coworker adjusted the pH to 3.7 for vegetable wine in which *Hibiscus sabdariffa* was used as substrate[24]. Patharkarand his coworkers conducted fermentation of orange at 4.5 pH[25]. These mashes were then incubated for a total of 5 days at a fixed temperature (25°C). The ideal temperature range for alcoholic fermentation is 20 to 28°C[13]. Lingappa and Naik reported that carrot wine fermented with immobilized cells of yeast at 27°C had higher ethanol content[22]. Vivek and Debjani carried out the fermentation of vegetable wine (carrot and beetroot) at 32°C[11] whereas according to Patharkar coworkers, 27°C is appropriate for orange wine[24]. The black carrot juice was fermented at 25°C by Kocher and colleagues[26]. Fermentation time varies depending on the fruit and other fermentation conditions. In

Table 1. Table displaying the composition, acidity level (pH), °brix, and fermentation temperature of various blends of fruit-veggie wines

Sl. No.	Blends	Composition of different blends	°Brix	Acidic level (pH)	Fermentation temperature	Brix after 5 days
1	AR1	Carrot (1kg) +Sugar Beet (5%)	18	3.87	25°C	0
2	AR2	Carrot (1kg) +Sugar Beet (5%)	20	3.81		
3	AR3	Carrot (1kg) +Sugar Beet (5%)		3.86		
4	AR4	Carrot (75%) + Orange (25%)	22	4.13		
5	AR5	Carrot (50%) + Orange (50%)		4.09		
6	AR6	Carrot (25%) + Orange (75%)		4.24		
7	AR7	Pure Carrot		4.27		
8	AR8	Pure Orange		4		

Table 2. Enological properties of fruit veggie-wine made with *S. cerevisiae*

Wines	Primary Specific gravity	Ultimate Specific gravity	Residual sugar	Apparent attenuation	Apparent fermentation degree	Fermentative capacity	Fermentative velocity
AR1	1.0741	1	0.00012	100	6.898	0.0741	135.85
AR2	1.083	1	0.00023	100	7.663	0.083	135.78
AR3	1.092	1	0.00012	100	8.424	0.092	135.86
AR4	1.092	1	0.00014	100	8.424	0.092	135.86
AR5	1.092	1	0.00012	100	8.424	0.092	135.86
AR6	1.092	1	0.00023	100	8.424	0.092	135.86
AR7	1.092	1	0.00025	100	8.424	0.092	135.86
AR8	1.092	1	0.00023	100	8.424	0.092	135.86

Table 3. The examination of physiological properties of wine through different methods

Wines	Total Acidity	Phenols (mg/100ml)	% Ethanol	Antioxidant activity	Vitamin Cg/l	Total SO_2 (mg/l)	Free SO_2 (mg/l)	Color density	Hue
AR1	0.57	96.3	10.06	96	5.25	35.2	58	0.90	0.945
AR2	0.63	99.6	11.27	90	5.5	35.2	78	1.52	1.140
AR3	0.42	97.2	12.56	95	5.75	41.6	83	1.56	1.153
AR4	0.60	108.33	12.52	89	5.75	28.8	88	1.14	1.674
AR5	0.57	117.26	12.58	85	6.3	35.2	80	1.74	2.928
AR6	0.54	111.88	12.51	83	6.55	22.4	89	2.56	1.411
AR7	0.49	125.0	12.57	89	6.9	32	87	1.11	0.619
AR8	0.54	198.0	12.56	87	6.4	32	99	2.17	0.853

ideal condition, musts typically finish fermenting in two to three weeks (Fig 2). In the current study, the fermentation took about 5 days to complete. As per Suryawanshi[18] and Patharkar[24] colleagues orange juice fermentation completes in 7 or 8 days. The fermentation of the vegetable wine lasted for 21 days, according to Vivek and Debjani[11]. Following fermentation, wines were racked for a month after being filtered through muslin cloth (Fig 4). The wines were then clarified and examined three times for each batch. The enological properties of wine developed in the present study are listed in Table 2. After fermentation, there was no pattern in the final specific gravities of the wines. Residual sugar was almost negligible in all wine blends.

Several methods were used to examine the physiochemical characteristics of wine (Table 3).The range of the total acidity was found to be

Fig. 1. Carrot-Beetroot must before fermentation

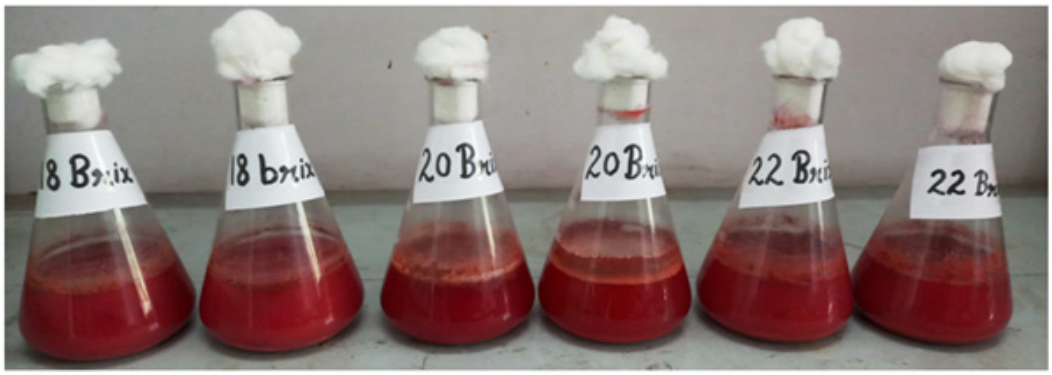

Fig. 2. Carrot-Beetroot must during fermentation

Table 4. Sensory and non-sensory data of different fruit-veggie wine blends

Blends	Mouth feel	Flavor	Pigmentation and look	Fragrance	Overall acceptability
AR1	8	9	9	9	8.75
AR2	7	9	9	8	8.25
AR3	8	9	9	7	8.25
AR4	8	8	8	9	8.25
AR5	9	7	8	8	7.75
AR6	8	9	8	8	8.25
AR7	9	8	9	8	8.50
AR8	8	8	9	9	8.50

0.4 to 0.6.Percent discoloration shown by wines was up to 96% (AR1). No major trend was found in Vitamin C content in different blends of wines.

Titrable acidity varied from 0.42 to 0.63 in all blends. Wine AR2 has maximum total acidity. Ethanol content ranged from 10 to 12.5%. Joshi and his coworkers reported that kinnow wine had an alcohol concentration of 8.57%[27]. Lingappa and Naik made carrot wines with an alcoholic content of 7.9% and 4.9%, respectively, using strain no. 522 and local yeast[17]. Singh and his colleagues standardized the kinnow wine

Fig. 3. Carrot-Beetroot must just after fermentation

Fig. 4. Different fruit vegetable wine blends after maturation of two months

Table 5. Table displaying non-sensory information for various fruit-veggies wine blends

Blends	Pigmentation	Relative sweetness	Alcoholic content	Fizz	pH
AR1	Light red	Dry	Natural	Still	Acidic
AR2	Dust red				
AR3	Red				
AR4	Mustard				
AR5	Light mustard				
AR6	Yellow				
AR7	Red				
AR8	Orange				

production conditions where they found that the maximum ethanol percentage was 11.3%[21]. Carrot-beet wine made by Vivek and Debjani had an alcohol level of 10.6±0.8%[9-11]. Our results were in accordance with the available literature with an alcohol content 10 to 12%. Vitamin C content ranged from 5 to 6.4 g/l in all the wines. Due to the concentration shift caused by heat lability, vitamin C is a critical quality indication that adds to the food's antioxidant capabilities[28, 29]. Antioxidant activity in wines was calculated as a percentage of DPPH inhibition. Comparing orange-carrot blends AR4, AR5, and AR6, it was found that carrot-beetroot blends AR1, AR2, and AR3 displayed greater antioxidant activity. Research demonstrates that carrots and beets are satisfying, juicy root vegetables with anti-inflammatory and antioxidant qualities. Phenolic contents varied from 96 to 198. Orange-beetroot blends have higher phenol content as compared to orange-beetroot blends. As per Vyas and Joshi, the plum wine fermented with and without peel had a phenol concentration of 208 mg/100 ml and 116 mg/100 ml, respectively[30]. Carrot and beet wine made by Vivek and Debjani[11] had an average phenol concentration of 0.22g/100 ml. Color and hue varied among different wine blends. Semi-trend panelists from Govt. College, Hisar, including students, instructors, and staff, help in sensory evaluation (Table 4).

Smell, taste, color, mouth feel, and general approval were the sensory evaluation criteria that were used for the data. Table 4 displays the sensory information for various wines made from various compositions.AR7 and AR8 are most liked among all the wines whereas AR5 is most disliked.

Almost all wines exhibit the same trend when tasted (according to non-sensory data). Due to the substrates used in this wine preparation, there is some color variance amongst various blends of fruit-veggie wine. All wines are acidic and lack any resemblance to sweetness. All wines naturally contain alcohol. Wines produced from such substrates like carrot, beetroot, and kinnow are considered to be healthy because of polynutrients present in both roots carrot and beetroots. Also, this wine contains antioxidants and photochemical that helps to maintain blood sugar level. As this wine contains antioxidants like vitamin C, it will be very beneficial for skin health. So, this study was planned by keeping all these health benefits in mind. This study aims to summarize the whole process used in preparation of fruit-veggie wine by using substrates like carrot, beetroot, and kinnow. This study will be useful to food manufacturers and processors for preparation of value-added wine to preserve the nutritional properties of different fruits and vegetables.

CONCLUSION

The tropics are home to several underutilized fruits and vegetables that can be used to produce wine. It has been determined that the wine made from carrot, beetroot, and orange is suitable and meets all the criteria for a decent wine in terms of colour, flavour, taste, aroma, and general acceptability for bouquet wines. Its acidic nature gives it an advantage in terms of storage ability and microbiological spoiling resistance. Carrots, beetroot, and oranges can be used as good substrates for the wine business because they are widely available and affordable. Commercial wine production could benefit from the use of fruits, vegetables, and wine mixes because doing so would help to preserve foreign currency. In addition, more research is required.

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Conflict of Interest

The authors declare that they have no competing interests. All authors read and approved the submission.

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