

Effects of Yeast and Oxygen on Quality Attributes of Wine Produced from Ethiopian Beetroot

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Abstract

The study was focused on the effects of yeast and oxygen on quality parameters of wine produced from Ethiopian beetroot such as Ethanol, Volatile Acidity, Titratable acidity, Specific Gravity and pH. The basic ingredients used for fermentation were water, sugar, yeast, beetroot juice and citric acid. The experimental set up was design through randomized block design with four fermentation treatments such as: F-1: specified beetroot juice mixed with water, sugar, acid and yeast and then placed under anaerobic fermentation. F-2: the conditions were similar with fermentation treatment one, rather yeast was absence. F-3: This also same condition as treatment condition one, but it was put under aerobic conditions and F-4: the conditions were the same as treatment two, but it placed under aerobic. The results obtained showed that treatment F1 of Ethanol- 13% w/v, TA- 0.65% v/v, VA- 0.15% v/v, pH- 3.49, SG- 0.99 and F2, F3 and F4 (15.5, 0.735, 0.11, 2.89, 1.12, 7.15, 0.6, 0.131, 3.31, 0.983 and 11.17, 0.622, 0.121, 3.53, 0.985) respectively. By using statically analysis and sensory analysis treatment F1-A was highly acceptable with ($p < 0.02008$) and panelist overall acceptance of 8.8 ± 0.61 . Finally, it can be conclude that beetroot juice treated with pure water, yeast, acid and sugar under anaerobic fermentation is produced wonderful wine.

Keywords: Beetroot; Wine; Fermentation; Yeast; Acid

Introduction

Production of wine was first discovered by ancient people using application of fermentation technology of fruits having sugar [1]. Today amateur winemaking is enjoyed by thousands of people throughout the world [2]. Wine consists of flavoring, sugar, acid, tannin and yeast but above all water [3,4]. The whole production of the wine has to be nurtured to perfection and this winemaking process must not be rushed. Wine is an alcoholic beverage produced through the partial or total fermentation of wine producing fruits. It is the fermented product of the fruit of several species of *Vitis*, mainly *V. vinifera* [5]. Though, the suitability of fruits other than grapes has been investigated all over the world, like sugar beet, banana, pineapple, beet root etc. [3]. Beetroot is a valuable vegetable, which is semi-hardy and biennial. It is grown year-round for its sweet, tender, succulent roots. Beets contain more sugar than any other vegetable, and its earthy taste and aroma comes from an organic compound called geosmin [6,7]. Beets of different colors, sizes and shaped have been grown, ranging from red, yellow, white, multi-colored, round, long cylindrical and huge sugar and mangle beets. Beet root has Red color naturally and its color is mostly stable at pH of 4.5-5.5; it is rather unstable outside this range [7,8]. The composition of beetroot, 100 g Nutritional value per 100 g (3.5 oz) Energy 180 kJ (43 kcal) Carbohydrates 9.56 g, 6.76 g of sugar), Dietary fiber 2.8 g, Fat 0.17 g, Protein 1.61 g, Water 87.58 g and others 0.72 g [5,6,8]. The process begins at the vineyard, where wine beetroot using special techniques for cultivating and maintaining the crop, depending upon the species of Beetroot and type of wine associated [4]. Thereafter, the Beetroot are harvested, upon which they are then either extracted of their juices, called the must, in a process called crushing either mechanically or by treading, the traditional method of basically stepping on the Beetroot in a large container.

Beetroot wines, as described in this project, are produced by fermented the raw beetroot juice, from which the alcohol that is produced during the fermenting process will begin to give acceptable wine characterize [9,10]. Fermentation commences by adding the juices, sugar and citric acid and yeast together which then produces alcohol and carbon dioxide [10]. The ethanol content of the beetroot fruit is in between, 7-14% [11]. Thus, the study was focused on the effects of yeast and oxygen in quality attributes of wine produced from Ethiopian beetroot

Experimental Materials and Methods

Aerial Beta vulgar type beetroot was collected from Adama town which is located 98 km far away the capital city of Ethiopia, and then transported to Adama Science and Technology University (ASTU), Chemical Engineering department, Food engineering laboratory. Then, the overall experimental work was set as shown in figure below (Figure 1). About 2.5 kg of beetroot fruit was cleaned or washed thoroughly and sliced thinly using knife after the fresh beetroot selected. The sliced one was placed in juice extractor to be extracted the juice from the beetroot fruit. The chemical composition and quality parameters of wine produced from beetroot were done before and after fermentation. The experimental set up of fermentation treatments were designed in such way: F-1: 0.25 kg Sugar, 15 ml of citric acid (to enhance distinct aroma/flavor), 2.25 L of water, 1.25 L of beetroot fruit juice and 0.0017 kg yeast was added and mixed together, then placed under anaerobic fermentation condition. F-2: 1.25 L of beetroot fruit juice was mixed with 0.25 kg Sugar, 15 ml of citric acid (to enhance distinct aroma/flavor), 2.25 L of water and no yeast; placed under anaerobic fermentation. F-3: 1.25 L of beetroot fruit juice was mixed with 10 ml citric acid, 2 L water and 0.0017 kg yeast; put under aerobic fermentation. F-4: 1.25 L of beetroot fruit juice was mixed with 10 ml citric acid, 2 L water and absence of yeast; placed under aerobic fermentation conditions. The chemical analysis of the product was

done before (at time of juice) and after 14 days of fermentation time. Total soluble solid (TSS) was measured by using Model-RF18 (India) handheld sugar refractometer. Titrable Acidity (TA) of the fruit was measured by means of an acid base titration method using a juice sample (10 ml juice+10 ml distilled water) and 0.1N Sodium hydroxide (NaOH) with phenolphthalein color indicator. Volatile Acidity (VA) within the distillate samples also expressed in terms of acetic acid mg/100 ml and pH was measured using digital pH meter. The specific gravity (SG) and alcohol content of the product (wine) were measured by hydrometer (AOA 2000 method). For the sensory evaluation tests,

fifteen panelists was selected from the university and the tests involved individuals in isolated tasting conditions. All panelists were asked to give their individual ratings on all quality attributes of stored fruits including color, aroma, taste, flavor, firmness and overall acceptability of the wine produced from different fermentation conditions using a 9-point structured hedonic scale to conduct the preference test: 1-dislike extremely and 9- like extremely. The scores marked by panelists were collected and an average was calculated for each parameter. One way Analysis of variance (ANOVA) was performed on the data collected using Microsoft excel and Origin Pro8 softwares.

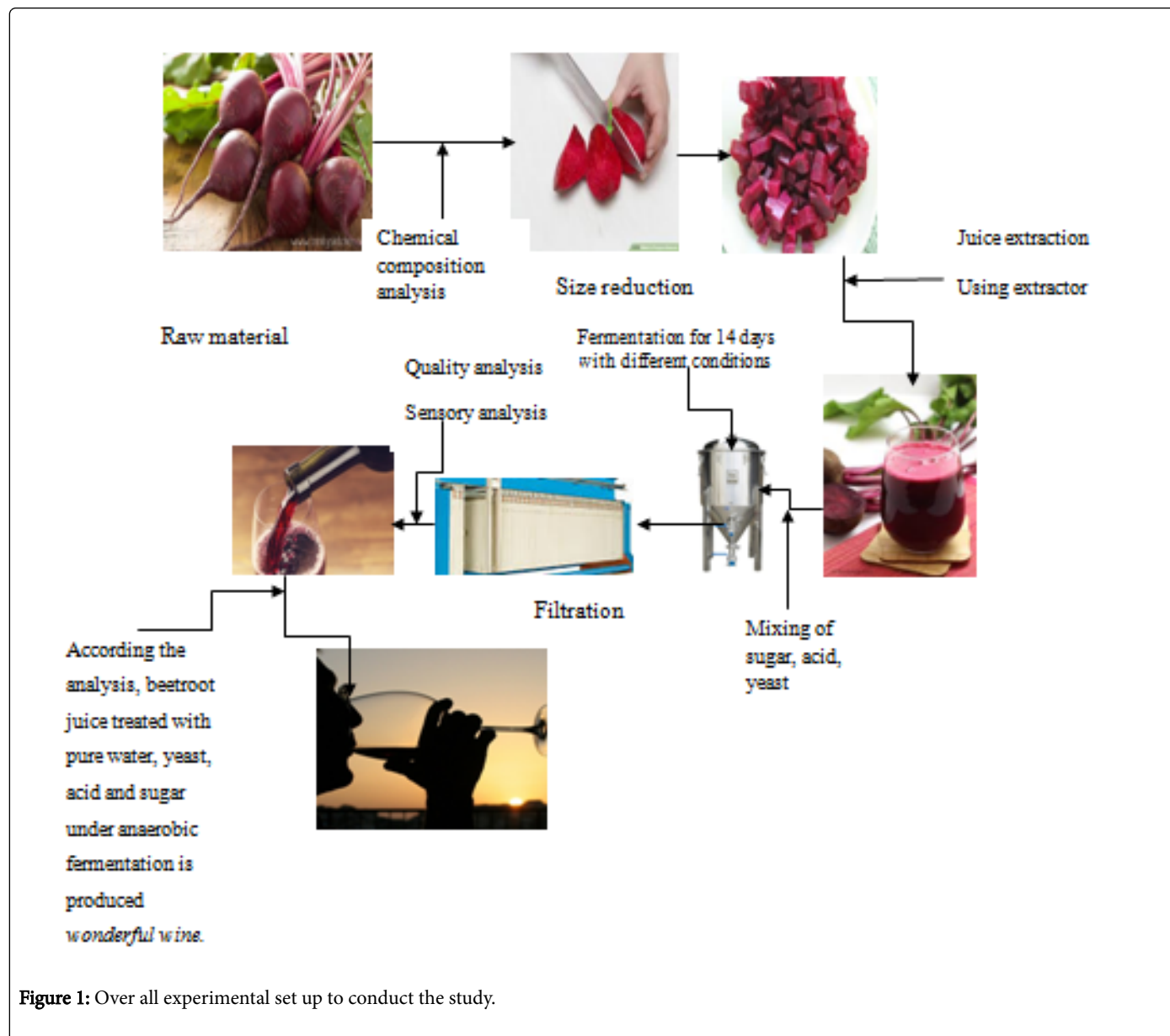


Figure 1: Over all experimental set up to conduct the study.

Results and Discussion

The effects of oxygen and yeast on quality and chemical composition of the product was presented in tables and figures.

Effect of oxygen on quality of wine

Wine produced from anaerobic (with no oxygen in excess) condition (F1-A) had high residual sugar and total soluble solid (24.5% w/v, 18% respectively) before fermentation; F4-D 15% TSS, 21% RS. The highest juice yield was recorded F1-A (640 ml/ kg) followed by 'B', C and D. The main prerequisite character of juice for fermentation is sugar content. Titrable acidity determined as tartaric acid range from

0.33 to 0.45% (w/v). The pH of the musts was 4.2 to 4.8. The low pH (4.8) was recorded in 'D' treatment condition, this is because lack in microbial activities (Table 1).

F-wines	Juice (ml/kg)	RS (% w/v)	TA (%)	pH	TSS* %
A-J1	640 ± 10	24.5 ± 1.22	0.33	4.2 ± 0.43	18.0 ± 1.24
B-J2	510 ± 13	18.5 ± 1.21	0.45	4.6 ± 0.86	16.2 ± 1.87
C-J3	550 ± 17	20.5 ± 1.24	0.36	4.3 ± 0.65	17.5 ± 0.79
D-J4	500 ± 22	21.0 ± 1.15	0.38	4.8 ± 1.10	15.5 ± 1.23

Table 1: Beetroot juice chemical compositions.

After fermentation the total sugar was converting in to 13% ethanol as well as for F4-D 9.7% ethanol (Figure 2), this result was similar with Ref. [12] report, the conversion of reducing sugar in to ethanol and carbon dioxide is due to the activity of microbes.

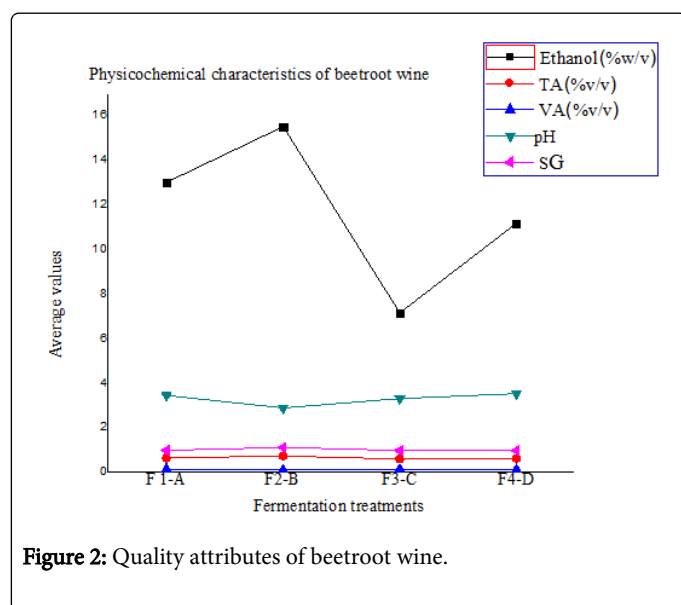


Figure 2: Quality attributes of beetroot wine.

Effect of yeast

The initial environment that affects the microbial makeup of a wine fermentation is that of the vineyard. Although a drastically different environment than juice or wine, the types of microbes present on grapes will have an impact on the ensuing ecology in the wine fermentation, particularly in the early stages. Microorganisms appear to colonize around the grape stomata where small amounts of exudates are secreted [13]. The spontaneous fermentations were shown to contain several different strains of *S. cerevisiae* that competed within the fermentation, while the inoculated fermentation was dominated by the inoculated strain [14,15]. The result showed that the effect of yeast in conversion of the simple carbohydrate to Ethanol, pH, TA, RS and VA was (13%, 0.65, 3.45, 2.1 and 0.15 respectively) under F1-A fermentation condition and for the other see on Table 2. The pH of the wine produced by aerobic fermentation type is low; this is due to the conversion of all the ingredients (activity of yeast) to the alcohol and has more acidic property. The pH of the wine produced by anaerobic fermentation type is likely moderate; this is due to the reason of fermenting without oxygen that means the nutrients contain in the

Fermented cannot be easily converted to alcohol, which shows the wine has weak acid characteristic. The percentage of ethanol percentage was higher with treatment F3 beetroot fermented wines (15.7%w/v) (Table 2) and highest content was in the wine produced from 'F3' and lowest in 'F4', this is because of yeast effect. Preparation of fruit beetroot fruit influenced the synthesis of higher alcohols during fermentation. Higher alcohols may influence certain sensory characteristics although they constitute a relatively lesser quantity of the total Substances. Fermentation changed the aroma of fruit juice, because of the production of yeast volatiles and the metabolism of original fruit volatiles. And it was affected by many factors like variety of fruit, clarification and fermentation conditions [13,16].

Wines	Ethanol (%w/v)	T.A (% v/v)	V.A (%V/V)	PH	SG	RS
F 1-A	13.0	0.65	0.15	3.45	0.99	2.1
F2-B	12.0	0.735	0.11	2.89	1.12	2.4
F3-C	15.7	0.6	0.131	3.31	0.983	2.0
F4-D	9.7	0.622	0.121	3.53	0.985	2.0

Table 2: Chemical compositions of the product/beetroot wine. T.A=Titration acidity; V.A=Volatile acidity.

Sensory evaluation

Wines produced by cells immobilized on grape skins have a better fruity aroma [16]. Similar results were also reported by Ref. [17] who found a considerable improvement in the wine sensory profile when fermentations were carried out in contact with the skins of Airen white wine grapes because of the transfer of the precursors of volatile compounds like esters, aldehydes, and alcohols into the wine. The wines produced by immobilized yeast biocatalyst showed fine clarity at the end of fermentation with low free cell concentrations as well as characteristic pleasant soft aroma and fruity taste [6]. The result showed that, wine produced under anaerobic fermentation with the inoculation of yeast (*S. cerevisiae*) had high over all acceptances (8.8±0.6) than that of produced without inoculating yeast (Figure 3).

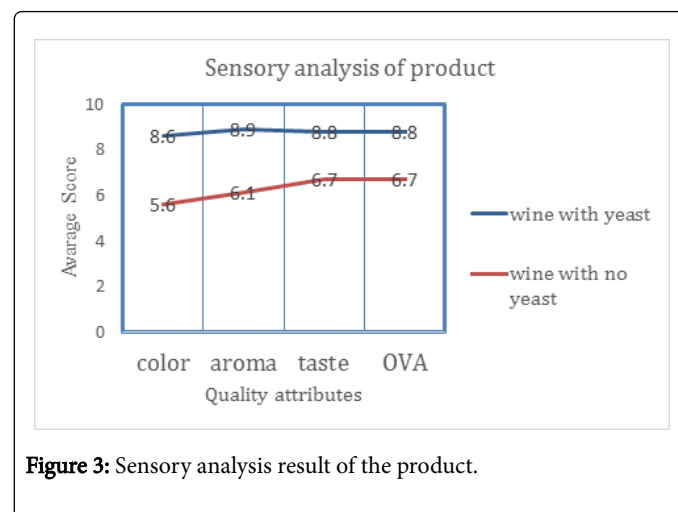


Figure 3: Sensory analysis result of the product.

Conclusions

Beetroot is a valuable vegetable and rich in nutrition, mainly it is rich in carbohydrate. By fermenting the mixed beetroot juice and then

purifying the product from by product obtained final analyzed wine. The quality of wine depends up on the compositions of the juice and fermentation conditions. The study was evaluate the quality and compositions of wine produced from beetroot by setting different fermentation treatments; mainly anaerobic condition with and without yeast and aerobic fermentation with and without yeast. Thus, the result showed that, wine produced from fermentation treatment one (F1-A) was best product based on its quality analysis and it was confirmed by sensory analysis. Finally, it can be conclude that beetroot juice treated with pure water, yeast, acid and sugar under anaerobic fermentation is produced wonderful wine.

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Competing Interests

The authors declare that they have no competing.

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