# Effect of different level of sugar and yeast on production and quality attributes of Apple Cider *(Malus x domestica)* cv. Royal Delicious


## ABSTRACT

An apple is a comestible fruit produced by an apple tree (*Malus x domestica Borkh*). Cider is generally defined as an alcoholic libation attained by stirring apple juice. Cider product also plays a promising part in the apple fruit assiduity and the libation assiduity. The present trial was carried out during 2022 in Post- Harvest Laboratory of Department of Horticulture, SHUATS, Prayagraj. The trial was conducted in Completely Randomized Design (CRD), with 9 treatments, replicated thrice. The treatments were T1- Apple Juice( 500 ml) Sugar( 100gm) incitement(0.5 gm), T2- Apple Juice( 500 ml) Sugar( 100gm) incitement(1.0 gm), T3- Apple Juice( 500 ml) Sugar( 100gm) incitement(1.5 gm), T4- Apple Juice( 500 ml) Sugar( 150gm) incitement(0.5 gm), T5- Apple Juice( 500 ml) Sugar( 150gm) incitement(1.0 gm), T6- Apple Juice( 500 ml) Sugar( 150gm) incitement(1.5 gm), T7- Apple Juice( 500 ml) Sugar( 200gm) incitement(0.5 gm), T8- Apple Juice( 500 ml) Sugar( 200gm) incitement(1.0 gm) and T9- Apple Juice( 500 ml) Sugar( 200gm) incitement(1.5 gm). From the present exploration it's set up that treatment T4- Apple Juice( 500 ml) Sugar( 150gm) incitement(0.5 gm), was set up superior in respect of the parameters TSS(° brix), Acidity(%), pH, Alcohol content(%), Ascorbic acid (mg/ 100 ml) Color and Appearance, Flavor and Taste, Texture and Overall Acceptability.



**Keywords:** Apple, yeast, sugar, Saccharomyces cerevisiae, fermentation.




## 1. INTRODUCTION

Apple is not only cultivated in India but, it is also common in other countries such as China, Russia, Ukraine, Poland, USA, Iran, France, Romania, Korea, Germany, Italy, Argentina, Japan, Spain, Chile, and Brazil [1]. In the north-western Himalayan region apple (*Malus x domestica* Borkh) is the most important temperate fruit. In India, the cultivation of apple was started by Captain Stoke during 1917-18. Out of the total apple production of India some state like, J&K, Uttarakhand and Himachal Pradesh contributes about 90% production. Besides these states, apple has also been cultivated to Nilgiri hills of Tamil Nadu and states of North-Eastern region viz. Meghalaya, Nagaland, Sikkim and Arunachal Pradesh in India. Some companies have begun adding preservatives and boiling cider, so that it can be shelf stable and stored without refrigeration. In either form, apple cider is seasonally produced in autumn.

Its nutritive popularity is notable and is an excellent source of carbohydrate (12.9 g/100g), sugar (9.2-11.8 g/100 g), fructose (5.7 g/100 g), glucose (0.6 g/100 g), sucrose (0.57 g/100 g), vitamin C (12 mg/100 g), proteins (0.3 g/100 g), pectin (0.5 g/100 g) and minerals such as Ca (7.0 mg/100 mg), Mg (3.20 mg/100 g), P (14.70 mg/100 g), Na (0.98 mg/100 g), Cu (0.04 mg/100 g), Fe (0.14 mg/100 g), Mn (0.04 mg/100 g) and Zn (0.09 mg/100 g) [2 & 3].

pH, total answerable solids( ° B), content of juice(), sugar acid rate, acidity() and acid attention() for apple fruit as4.22,10.36,0.56,36.35,4.26 and0.29 independently. Apple's remedial value is also notable for colorful habitual ails [4]. Further than 2000 time in the Eastern Mediterranean region, apple juice was instigated to gain a affable alcoholic libation [5]. Presently apple juice is instigated to manufacture cider which is a foamy and stimulating fruit seasoned libation, consumed

in numerous countries around the world along with sugar [6 & 7].

The undressed juice of apple is used to prepare cider, which is a fermented ethanolic libation. The ethanol content varies from 2.25 to 8.5 ( v/ v). Apple possesses balanced quantum of nutritional mariners for incentive to naturally produce a stable and potable libation. Ethanolic libation in utmost countries is prepared in one way or the other for turmoil of original fruits to produce their ciders [8]. Reflect that tannins are an aggregation of polyphenols which give astringency and bitterness to the cider and is essential for its high organoleptic trait. Likewise, colorful conditions like malice and cardiovascular ails can repel by phenolics which is present in apple. Cider is also most popular in United Kingdom, especially in the West region, and extensively available. World's loftiest per capita consumption of cider along with largest cider-producing companies was contributed by United Kingdom. Cider is also popular in numerous Commonwealth countries, like New Zealand, Australia and Canada and other European countries which including Spain, France, Ireland and Portugal [9].

Cider timber process includes colorful way similar as harvesting apple fruit, sweating, washing, grinding, pressing, blending, testing, turmoil, racking off, filtering or fining, bottling and storehouse. Cider is produced all over the world and consumed throughout the European countries. Overall cider goes through three introductory stages which is essential for cider making first stage, in afterlife the ripe fruit is crushed; alternate stage, the juice is pressed out and third and final stage the juice may be instigated for weeks or months, but generally by late downtime the finished cider is bottled. In the U.S. and corridor of Canada fermented juice of apple known as hard cider where as non-alcoholic or unfermented apple juice is consider as non- alcoholic cider or sweet cider. The flavor of cider varies from dry to sweet. Their appearance ranges from cloudy to fully clear, and color ranges from nearly tint less to amber or brown. As a low alcoholic drink, cider is veritably popular in several European countries where because of peculiar climatic conditions. Cider could be hard or soft, though it has been produced for over two glories. India produces a large volume of apple and cider product could come an important tool for diversification and forestallment of postharvest losses. The scientific aspects of its product are less proved than other analogous potables [10].

## 2. MATERIALS AND METHODS

The Experimental was conducted in Completely Randomized Design (CRD) with 9 treatments of different level of sugar and yeast Apple Cider with three replications in the Post Harvest Laboratory of Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during 2022. Total number of treatments was nine.

2.1 Climate of experimental location

2.2 Details of treatment

2.3 Apple cider preparation

2.4 Observations recorded

### 2.1 Climate of experimental location

Allahabad is 98 meter above the mean sea level is situated at 25.78º N latitude and 81.5º E longitudes. Allahabad has subtropical climatic conditions prevailing in the southern part of Uttar Pradesh which both the extremes of temperature i.e., winter and summer

**Table 1. Details of experiment**

| | |
|---|---|
| Fruit Material | Apple (*Malus* X *Domestica* L.) |
| Cultivar | Royal Delicious |
| Total No.Of Treatment | 9 |
| Total No.Of Replication | 3 |
| Experimental Site | (CRD) Complete Randomized Design |
| Experimental Site | Post Harvest Lab Department Of Horticulture Naini Agriculture Institute Shuats Prayagraj |

### 2.2 Details of treatment

The experiment consists of 9 treatment combination with different concentration of apple

juice, sugar and yeast with three replications. The details of treatments are given below:

Number of treatments:

T1-Apple Juice (500ml) +Sugar (100g) + Yeast (0.5g)

T2-Apple Juice (500ml) + Sugar (100g) + Yeast (1.0g)

T3-Apple Juice (500ml) + Sugar (100g) +Yeast (1.5g)

T4-Apple Juice (500ml) + Sugar (150g) + Yeast (0.5g)

T5 -Apple Juice (500ml) + Sugar (150g) + Yeast (1.0g)

T6-Apple Juice (500ml) + Sugar (150g) + Yeast (1.5g)

T7-Apple Juice (500ml) + Sugar (200g) + Yeast (0.5g)

T8-Apple Juice (500ml) + Sugar (200g) + Yeast (1.0g)

T9-Apple Juice (500ml) + Sugar (200g) + Yeast (1.5g)

### 2.3 Apple cider preparation

The apple fruit were procured from the Apple Orchard from Manali, Himachal Pradesh. For preparing the apple base cider, juice was ameliorated with fermentable sugars (apple) as the TSS was about 8.0 to 9.0° Brix in the case of apple juice i.e., sugar source needs to be added to produce ethanol. The fermentation conditions optimized earlier were used.

#### 2.3.1 Apple juice extraction

Juice was pressed out from apple fruits. Fruits were washed, hulled and cut into small pieces. The fruits were grated by using domestic mixer grinder and the apple juice was uprooted by filtering grated apple through a muslin cloth.

#### 2.3.2 Preparation of yeast cultures

Dried cider yeast a commercial strain of Saccharomyces cerevisiae was obtained from the local market. The active culture was made by addingSaccharomyces cerevisiae for the preparation of cider. For making yeast culture, yeast was activated and poured into a small amount of apple juice and mixed then it was transferred back to the flask containing 500 ml of sterilized apple juice.

#### 2.3.3 Fermentation

The apple must be incubated with a 5% starter culture of Saccharomyces cerevisiae. Fermentation was carried out in bottles at room temperature (20-22°C). The content was shaken 3-4 times and a fall in degree brix was recorded regularly. The observation was continued till steady-state values were obtained. The fermentation was considered complete when a stable TSS was reached. Throughout the fermentation process, the cider must be monitored for TSS.

#### 2.3.4 Bottling

The blended product was poured into 500 ml capacity hot and sterilized bottles and kept air-tight.

#### 2.3.5 Storage

The bottles of blended product were kept for further studies up to 90 days of storage period at ambient condition.

### 2.4 Observations recorded

1. Overall adoptability (Organoleptic test)
    - Color
    - Taste
    - Appearance
    - Flavor & aroma
    - Overall acceptability

2. Quality parameters
    - TSS
    - Acidity
    - pH
    - Alcohol content
    - Ascorbic acid

## 3. RESULT AND DISCUSSION

The results of the present investigation, regarding the Effect of different levels of sugar and yeast on production and quality attributes of Apple Cider *(Malus x domestica)* cv. Royal Delicious have

been discussed and interpreted. The experiment was conducted in a Completely Randomized design with 9 treatments and three replications. The data were statistically analyzed and results are being reported under the following heads. Based on both the sensory and chemical characteristics the treatments, T4[(Apple Juice(500ml)+Sugar(150g)+(Yeast(0.5g)] adjudged as the best cider than the other treatments. On the basis of physio-chemical and sensory quality characters, treatment T4 was prominently superior due to optimum acidity, TSS, pH, ascorbic acid, color, appearance, flavor, taste and overall quality of apple cider upto 90 days of storage. The color, appearance, flavor& aroma, taste and overall quality were increased continuously upto 90 days of storage.

The data on the stored apple cider with respect to color, taste, appearance, flavor &aroma and overall adaptability were statically analyzed. It is clear from table and figure at 0, 30, 60 and 90 days of storage there was significant difference amongst various treatments.

**3.1 Organoleptic Test**

It's apparent that the table 1 was told by different treatments at consecutive stage 90 days of storage. There were significant differences between the treatments. The organoleptic test on color treatment T4 [( Apple Juice( 500 ml) Sugar( 150gm)] incentive (0.5 gm) with (7.50) have loftiest color score followed by T7 [(Apple Juice( 500 ml) Sugar( 200gm)] incentive (0.5 gm) with(7.40) of were significantly superior than minimal color score in T1 [( Apple Juice( 500 ml) Sugar( 100gm)] incentive (0.5 gm)) with(6.50) independently. also in Taste Treatments T4[( Apple Juice( 500 ml) Sugar( 150gm) incentive(0.5 gm)) with (,7.50) have loftiest taste score followed by T7 [(Apple Juice( 500 ml) Sugar( 200gm)] incentive (0.5 gm) with(7.30) of were significantly superior than taste in T1 [( Apple Juice( 500 ml) Sugar(100gm)] incentive (0.5 gm) with (6.30) respectively. However, in Appearance Treatments T4 [( Apple Juice( 500 ml) Sugar( 150gm)] incentive (0.5 gm) with (7.40) have loftiest appearance score followed by T7 [(Apple Juice( 500 ml) Sugar( 200gm)] incentive (0.5 gm) with(7.30) of were significantly superior than appearance in T1[( Apple Juice( 500 ml) Sugar( 100gm)] incentive(0.5 gm)) with(6.40) independently. In Flavor & aroma Treatments T4 [( Apple Juice( 500 ml) Sugar( 150gm)] incentive(0.5 gm)) with(8.10) have loftiest flavor & aroma score followed by T7 [(Apple Juice( 500 ml) Sugar( 200gm)] incentive(0.5 gm)) with(7.20) of were significantly superior than flavor & aroma in T1[( Apple Juice( 500 ml) Sugar( 100gm)] incentive(0.5 gm)) with(6.30) independently. also, Overall quality treatments T4[( Apple Juice( 500 ml) Sugar( 150gm)] incentive(0.5 gm)) with(7.60) have the loftiest overall quality score followed by T7 [(Apple Juice( 500 ml) Sugar( 200gm)] incentive(0.5 gm)) with(7.30) of were significantly superior to overall quality in T1 [( Apple Juice( 500 ml) Sugar( 100gm)] incentive(0.5 gm)) with(6.40) independently. The taste and flavor quality of cider are dependent upon the composition of the apple, the artificial process used for juice birth, and the turmoil process [11]. Increase in sugar attention increased the niceness and dropped the harshness of apple juice. The high chance of juice might have dropped the cider appearance and increased the apple appearance shifting further towards soft cider rather than hard. The primary characterization of cider is a racy sweet apple which occurs to a lesser or lowers extent in all cider. Therefore, it differentiates the ciders from other fermented potables. The changes in the perceived appearance of the cider could incompletely be attributed to the enhanced apple appearance of the juice and incompletely to the impact of the sugar of the juice added. An increase in sugar attention increased the niceness and dropped the harshness of apple juice. The high chance juice might have dropped the cider flavor and increased apple flavor shifting further towards soft cider rather than hard. The primary characterization of cider is a racy sweet apple which occurs to a lesser or lowers extent in all cider. Therefore, it differentiates the ciders from other fermented potables. The changes in the perceived flavor of the cider could incompletely be attributed to the enhanced apple flavor of juice and incompletely to the impact of the sugar of the juice added [12]. In all the sensitive quality attributes, viz. color, appearance, flavor & aroma, taste, and overall quality, mix with 45 percent juice was arbitrated to be the stylish product as apple cider followed by mix with 40 and 50 percent juice.

**Color**

As per my result, there was significant differences between the treatments at 0, 30, 60 and 90 days, among the treatment used T4[(Apple Juice(500ml) +Sugar(150g)+Yeast(0.5g)]with (7.30,7.30,7.40 and 7.50 ) have highest color score followed by T7 [Apple Juice(500ml) + Sugar(200g)+Yeast (0.5g)]with (6.70,6.80,7.10

and 7.40)

**Taste**

T4 [( Apple Juice(500ml)+ Sugar (150g)+ Yeast (0.5g) with (7.10,7.20,7.50) have highest taste score followed by T7[Apple Juice (500ml)+ Sugar (200g)+Yeast (0.5g)] with (6.80,6.90,7.10 and 7.30).As per my result it might be partly due to-the masking effect of sugar and partly due to the flavor of apple juice. The taste and flavor quality of cider are dependent upon composition of apple. Increase in sugar -concentration increased the pleasantness and decreased the hardness of apple juice [13].

**Appearance**

T4 [(Apple Juice (500ml) + Sugar (150g)+ Yeast (0.5g)]with (7.20,7.30,7.40and7.40)have highest appearance score followed by T7[Apple Juice(500ml)+Sugar(200gm)+ Yeast (0.5gm)]with (6.60, 7.20, 7.20 and 7.30). As per my result the changes in the perceived appearance of the cider could pertly be attributed to the enhanced apple appearance of juice and partly to the impact of the sugar of the juice added.

**Flavor & aroma**

T4[(Apple Juice(500ml) + Sugar(150g)+ Yeast(0.5g)]with (7.10,7.40,7.40 and 8.10) have highest flavor & aroma score followed by T7[AppleJuice(500ml)+Sugar(200g)+Yeast(0.5g)] with(6.40,6.60,7.10and7.20. It might be partly due to the masking effect of sugar and partly due to the flavor of apple juice. Increase in sugar concentration increased the pleasantness and decreased the harshness of apple juice. The high percentage juice might have decreased the cider flavor and increased apple flavor shifting more towards soft cider rather than hard. The primary characterization of cider is a spicy aromatic apple which occurs to a greater or lesser extension all the cider. Thus, it differentiates the ciders from other fermented beverages.

**Overall acceptability**

It is evident that the overall quality was influenced by different treatments at all successive stage of storage. There was significant differences between the treatments at 0,30,60 and 90 days, among the treatment used T4 [(Apple Juice (500ml)+ Sugar (150g)+ Yeast (0.5g) with (7.20,7.30,7.40 and 7.60) have highest overall quality score followed by T7 [(Apple Juice (500ml)+ Sugar (200g)+ Yeast (0.5g)] with (6.60,6.90,7.10 and 7.30) of were significantly superior than overall quality in T1 [(Apple Juice (500ml)+ Sugar(100g)+ Yeast(0.5g)] with (5.80,6.10,6.40 and 6.40) respectively. Increase in sugar concentration increased the pleasantness and decreased the harshness of apple juice. The high percentage juice might have decreased the cider flavor and increased apple flavor shifting more towards soft cider rather than hard. The primary characterization of cider is a spicy aromatic apple which occurs to a greater or lesser extension of all the cider. Thus, it differentiates the cider from other fermented beverages.

In all the sensory quality attributes, viz. Color, Appearance, Flavor & Aroma, Taste and Overall Quality, blend with 45 percent juice was adjudged to be the best product as apple cider followed by blend with 40 and 50 percent juice.

## 3.2 Quality parameters

It is evident that the table 2 was influenced by different treatments at successive stage 90 days of storage. There were significant differences between the treatments. The quality parameters on TSS (° Brix) treatment T4[(Apple Juice(500ml) + Sugar(150gm)+ Yeast (0.5gm)]with (7.90, 7.63, 7.10 and 6.87) have highest TSS (° Brix) followed by T7[Apple Juice(500ml) + Sugar(200gm)+ Yeast (0.5gm)] with (7.85, 7.75, 7.15 and 6.68) of were significantly superior than TSS (° Brix) in

T1[(Apple Juice(500ml) + Sugar(100gm)+ Yeast (0.5gm)] with (6.78, 6.48, 5.98 and 5.42) respectively. Similarly in Acidity (%) treatment T4[(Apple Juice(500ml) + Sugar(150gm)+ Yeast (0.5gm)]with (0.36, 0.38, 0.46 and 0.55) have highest acidity (%) followed by T7[Apple Juice(500ml) + Sugar(200gm)+ Yeast (0.5gm)] with (0.33, 0.35, 0.40 and 0.48) of were significantly superior than acidity (%) in T1[(Apple Juice(500ml) + Sugar(100gm)+ Yeast (0.5gm)] with (0.25, 0.27, 0.30 and 0.34) respectively. In case of pH (%) treatments T4[(Apple Juice(500ml) + Sugar(150gm)+ Yeast (0.5gm)]with (3.01) have highest pH (%) followed by T7[Apple Juice(500ml) + Sugar(200gm) + Yeast (0.5gm)] with (2.96) of were significantly superior than pH (%) in T1[(Apple Juice(500ml) + Sugar(100gm)+ Yeast (0.5gm)] with (2.7) respectively.

**Table 2: Effect of different treatments on sensory evaluation of stored apple cider**

| Treatments | Color | Taste | Appearance | Flavor & aroma | Overall quality |
|---|---|---|---|---|---|
| $T_1$-Apple Juice(500ml) + Sugar(100gm)+ Yeast (0.5gm) | 6.5 | 6.3 | 6.4 | 6.3 | 6.4 |
| $T_2$-Apple Juice(500ml) + Sugar(100gm)+ Yeast (1.0gm) | 6.7 | 6.4 | 6.6 | 6.5 | 6.5 |
| $T_3$-Apple Juice(500ml) + Sugar(100gm)+Yeast (1.5gm) | 6.6 | 6.6 | 6.7 | 6.9 | 6.7 |
| $T_4$-Apple Juice(500ml) + Sugar(150gm)+ Yeast (0.5gm) | 7.5 | 7.5 | 7.4 | 8.1 | 7.6 |
| $T_5$ -Apple Juice(500ml) + Sugar(150gm)+ Yeast (1.0gm) | 6.4 | 6.7 | 6.7 | 6.3 | 6.5 |
| $T_6$-Apple Juice(500ml) + Sugar(150gm)+ Yeast (1.5gm) | 6.9 | 6.6 | 6.8 | 6.4 | 6.7 |
| $T_7$-Apple Juice(500ml) + Sugar(200gm)+ Yeast (0.5gm) | 7.4 | 7.3 | 7.3 | 7.2 | 7.3 |
| $T_8$-Apple Juice(500ml) + Sugar(200gm)+ Yeast (1.0gm) | 6.5 | 6.4 | 6.6 | 6.6 | 6.5 |
| $T_9$-Apple Juice(500ml) + Sugar(200gm)+ Yeast (1.5gm) | 6.7 | 7.3 | 6.6 | 7.9 | 7.1 |
| F- Test | S | S | S | S | S |
| S. Ed. (±) | 0.317 | 0.251 | 0.266 | 0.244 | 0.256 |
| C.D. at 5% | 0.672 | 0.533 | 0.564 | 0.518 | 0.543 |
| CV | 17.367 | 13.77 | 14.575 | 13.383 | 14.029 |

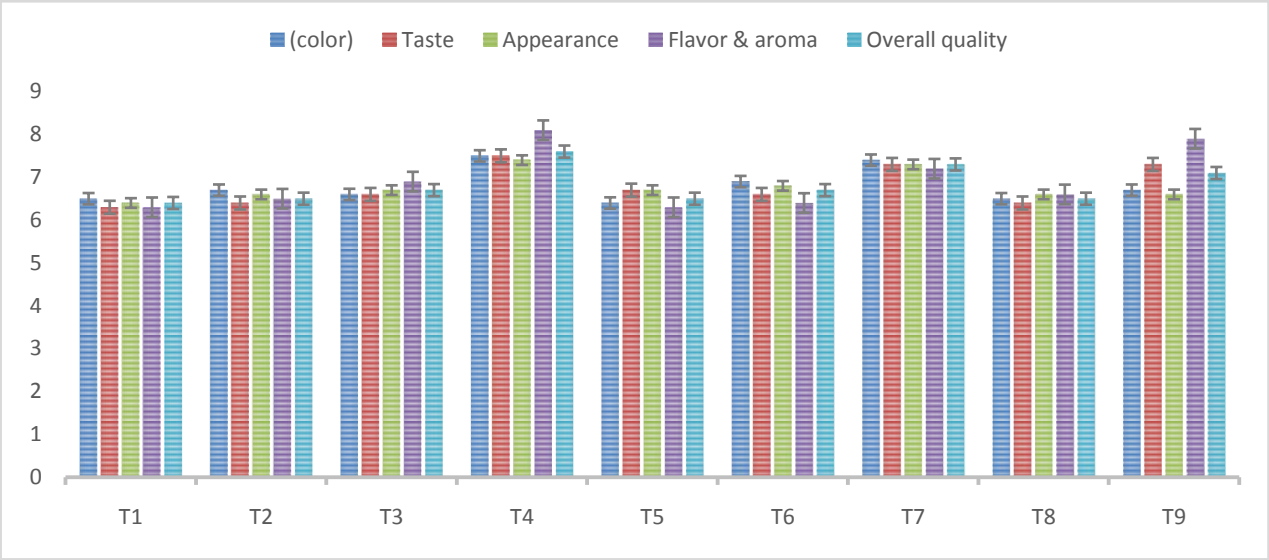


**Figure 1: Effect of different treatments on sensory evaluation of stored apple cider**

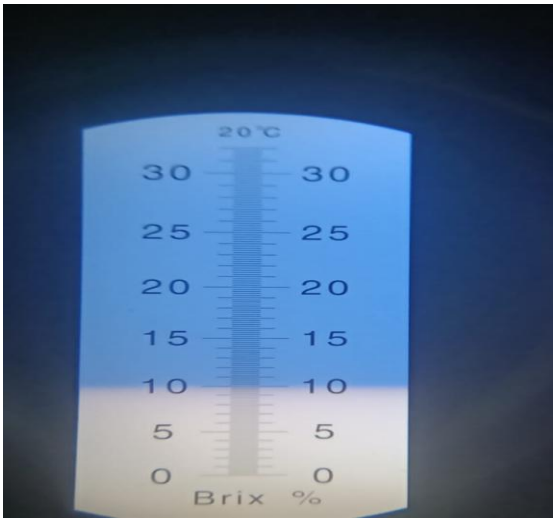


**Figure 2: Taking the TSS of apple cider**


**Figure 3: Taking the pH of apple cider**


**Figure 4: Final Product**

Similarly in Alcohol content (%) treatment T4[(Apple Juice(500ml) + Sugar(150gm)+ Yeast (0.5gm)]with (9.62) have highest alcohol content (%) followed by T7[Apple Juice(500ml) + Sugar(200gm) + Yeast (0.5gm)] with (8.45) of were significantly superior than alcohol content (%) in T1[(Apple Juice(500ml) + Sugar(100gm)+ Yeast (0.5gm)] with (6.94) respectively. However in Ascorbic acid (mg/100 ml) treatment T4[(Apple Juice(500ml) + Sugar(150gm)+ Yeast (0.5gm)]with (9.62) have highest ascorbic acid (mg/100 ml) followed by T7[Apple Juice(500ml) + Sugar(200gm) + Yeast (0.5gm)] with (8.45) of were significantly superior than ascorbic acid (mg/100 ml) in T1[(Apple Juice(500ml) + Sugar(100gm)+ Yeast (0.5gm)] with (6.94) respectively [14]. studied the production of cider from mango varieties by using various strains Saccharomyces cerevisiae showed declining trend in TSS was noted after storage of 45 days

ranged between 3.00 to 7.00° Brix and 3.50 to 7.50° Brix with Saccharomyces cerevisiae MTCC 172 and Saccharomyces cerevisiae AM 113, respectively in all the treatments. After 90 days total soluble solids of the same declined further ranging from 1.00° Brix to 2.00° Brix and 1.50° Brix to 2.50° Brix respectively [15].The decrease in TSS during maturation in strawberry cider was might be due to precipitation of soluble solids during interaction of various components [16]. Recorded the decrease in TSS in tendu cider from 20 to 2° Brix.

The increase in acidity in the wines could be due to production of acids [17]. Recorded that the apple juice was fermented by using yeasts and then the yeasts produced some organic acid such as succinic acid, lactic acid and malic acid during fermentation [18]. Recorded that other organic acids such as tartaric, oxalic, malic, lactic, succinic and citric acids were produced during fermentation [19]. studied tropical bael *(Aegle marmelos L.)* fruits for production of wine by using wine yeast (Saccharomyces cerevisiae) and recorded that the titratable acidity of beal wine was increased from 0.08 (g tartaric acid/100 ml) to 0.15 (g tartaric acid/100 ml) in wine during storage. The similar results were reported [20]. They observed the notable decrease in pH of mango wine during 3 months of storage. These findings were confirmed [21]. in Ber cider. The decrease in pH was might be due to acquisition of organic acids such as lactic acid during fermentation and it decreases the incidence of spoilage bacteria [22].Therefore, this might be due to the reason that the quantity of sugars (total sugar, reducing sugar and non-reducing sugar) reduces over the period of storage clearly indicates that the yeast was utilized sugar completely for conversion into alcohol and a part of it was also converted to other metabolites such as lactic acid and methanol. This could be due to the availability of food, favorable acidity and pH and efficiency of the yeast to consume sugars [ 23]. studied in jamun cultivars for production of wine and they observed that the reducing sugars were decreased from 0.32 to 0.18 g/100 ml. The low content of residual sugars of litchi wines indicates that almost all the reducing sugars were consumed during fermentation[24].To protect the wine against oxidative changes these acids may have served as an oxygen scavenger [25]. reported the same with Roselle wine in which the ascorbic acid content was reduced by 35.7%. Observed that the ascorbic acid content was decreased from 1.26 mg/100g to 1.19 mg/100g in mahua vermouth during one year of maturation. Loss of ascorbic acid during storage of fruit wines was reported [26]. Observed the decrease in ascorbic acid content in tendu cider.

**TSS**

T4[(Apple Juice(500ml) + Sugar(150g)+ Yeast (0.5g)]with (7.90,7.63,7.10and6.87) have highest TSS(°Brix) followed by T7[AppleJuice(500ml)+Sugar(200g)+ Yeast (0.5g)]with (7.85, 7.75, 7.15 and 6.68). The complete utilization of sugar might be the reason of decrease in the TSS during storage period. [27]

**Acidity**

T4[(Apple Juice(500ml) + Sugar(150g)+ Yeast (0.5g)]with (0.36,0.38,0.46and0.55) have highest acidity(%) followed by T7[AppleJuice(500ml)+Sugar(200g)+ Yeast (0.5g)]with (0.33, 0.35, 0.40 and 0.48). During storage yeast produced certain organic acid, which might be the reason of increasing acidity in apple cider.

**Table 3: Effect of different treatments on quality parameters of stored apple cider**

| Treatments | TSS (° Brix) | Acidity (%) | pH (%) | Alcohol content (%) | Ascorbic acid (mg/100 ml) |
|---|---|---|---|---|---|
| $T_1$-Apple Juice(500ml) + Sugar(100gm)+ Yeast (0.5gm) | 5.42 | 0.34 | 2.7 | 6.94 | 0.32 |
| $T_2$-Apple Juice(500ml) + Sugar(100gm)+ Yeast (1.0gm) | 7.28 | 0.53 | 2.9 | 7.98 | 0.46 |
| $T_3$-Apple Juice(500ml) + Sugar(100gm)+Yeast (1.5gm) | 6.32 | 0.5 | 2.84 | 8.29 | 0.38 |
| $T_4$-Apple Juice(500ml) + Sugar(150gm)+ Yeast (0.5gm) | 6.87 | 0.55 | 3.01 | 9.62 | 0.49 |
| $T_5$ -Apple Juice(500ml) + Sugar(150gm)+ Yeast (1.0gm) | 6.12 | 0.46 | 2.78 | 7.71 | 0.4 |
| $T_6$-Apple Juice(500ml) + Sugar(150gm)+ Yeast (1.5gm) | 6.67 | 0.45 | 2.79 | 8.88 | 0.43 |
| $T_7$-Apple Juice(500ml) + Sugar(200gm)+ Yeast (0.5gm) | 6.68 | 0.48 | 2.96 | 8.45 | 0.48 |
| $T_8$-Apple Juice(500ml) + Sugar(200gm)+ Yeast (1.0gm) | 6.6 | 0.38 | 2.83 | 7.24 | 0.34 |
| $T_9$-Apple Juice(500ml) + Sugar(200gm)+ Yeast (1.5gm) | 5.78 | 0.42 | 2.87 | 7.19 | 0.36 |
| F- Test | S | S | S | S | S |
| S. Ed. (±) | 0.3 | 0.838 | 0.208 | 0.263 | 0.263 |
| C.D. at 5% | 0.636 | 1.729 | 0.442 | 0.557 | 0.557 |
| CV | 16.434 | 2.236 | 11.409 | 14.392 | 14.392 |

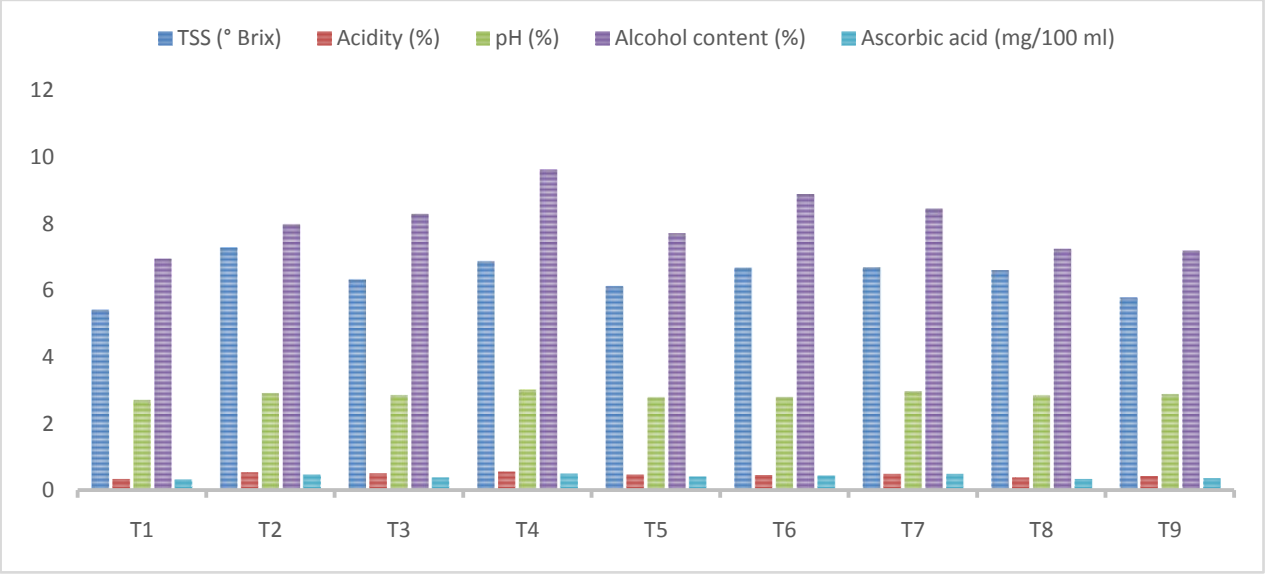


**Figure 5: Effect of different treatments on quality parameters of stored apple cider**

**pH**

T4[(Apple Juice(500ml) + Sugar(150g)+ Yeast (0.5g)]with (0.36, 0.38, 0.46 and 0.55) have highest pH (%) followed by T7[Apple Juice(500ml) + Sugar(200g)+ Yeast (0.5g)] with (0.33, 0.35, 0.40 and 0.48). The decrease in pH in different wines is due to increase in acidity.

**Alcohol content**

T4[(Apple Juice(500ml) + Sugar(150g)+ Yeast (0.5g)]with (8.48, 8.86, 9.24 and 9.62) have highest alcohol content (%) followed by T7[Apple Juice(500ml) + Sugar(200g)+ Yeast (0.5g)] with (7.31, 7.69, 8.07 and 8.45). Therefore, this might be due to the reason that the quantity of sugars (total sugar, reducing sugar and non-reducing sugar) reduces over the period of storage clearly indicates that the yeast was utilized sugar completely for conversion into alcohol and a part of it was also converted to other metabolites such as lactic acid and methanol [28].

**Ascorbic acid**

T4[(Apple Juice(500ml) + Sugar(150g)+ Yeast (0.5g)]with (8.48, 8.86, 9.24 and 9.62) have highest ascorbic acid (mg/100 ml) followed by T7[Apple Juice(500ml) + Sugar(200g) + Yeast (0.5g)] with (7.31, 7.69, 8.07 and 8.45). Heat destruction and oxidation was might be the reason for ascorbic acid reduction during storage period. To protect the wine against oxidative changes these acids may have served as an oxygen scavenger [29]. Additionally, other apple products are obtained through fermentation processes, such as probiotic fermented apple juices [30&31] and cider [32&33], or fermented products obtained from apple pomace generated as industrial by-products.

## 4. CONCLUSION

Based on both the sensory and chemical characteristics the treatments, T4[(Apple Juice(500ml) + Sugar (150g)+ Yeast (0.5g)] adjudged as the best cider than other treatments. On the basis of physio-chemical and sensory quality characters, treatment T4 was prominently superior due to optimum acidity, TSS, pH, ascorbic acid, color, appearance, flavor, taste and overall quality of apple cider up to 90 days of storage. The color, appearance, flavor& aroma, taste and overall quality were increased continuously up to 90 days of storage.

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