Original Research Article

Effect of yeast and different levels of sugar on Indian olive (*Elaeocarpus serratus* L.) cider

ABSTRACT

The study was conducted in Completely Randomized Design (CRD) with 8 treatments replicated three times. The treatments were T1 (Indian olive 500g +250ml water +150g sugar), T2 (Indian olive 500g +250ml water +200g sugar), T3 (Indian olive 500g +250ml water +250g sugar), T4 (Indian olive 500g +250ml water +300g sugar), T5 (Indian olive 500g +250ml water +150g sugar +1.5g yeast), T6 (Indian olive 500g +250ml water +200g sugar +1.5g yeast), T7 (Indian olive 500g +250ml water +250g sugar +1.5g yeast) and T8 (Indian olive 500g +250ml water +300g sugar +1.5g yeast). Total soluble solids, pH and specific gravity decreased while alcohol content, acidity and sensory qualities increased with increasing length of fermentation. From the above treatments, it is concluded that treatment T5 was found superior in respect of parameters like total soluble solids, pH, acidity, alcohol content, and specific gravity. Whereas color and appearance, aroma, taste, and overall acceptability was recorded in T6. In terms of gross return, net return and cost-benefit ratio, treatment T6 was recorded highest. Since Indian olive contains numerous nutritional and medicinal properties and is still underutilized, the production of cider from this fruit can help reduce post-harvest losses. This study showed that acceptable cider can be produced from Indian olive using yeast (*Saccharomyces cerevisiae).*

Keywords: Cider, Indian olive, *Saccharomyces cerevisiae*, Sugar, Fermentation

INTRODUCTION

(*Elaeocarpus serratus* L.) commonly known as Indian olive or wild olive or ceylon olive is a subtropical fruit tree belonging to family Elaeocarpaceae. It is indigenous to Sri Lanka and the fruit tree is found in some parts of North Eastern states of India. It requires warmer

conditions and are sensitive to frost and large fluctuations in temperatures. It is a large, evergreen, drought-tolerant, perennial broad leave tree with a large spreading crown. It attains a height of about 50-200 ft., 5-10 m in canopy spread, blooms during September-October and fruiting occurs during January. Fruits are ovoid or globose berries of 4-5 cm long weighing 3.58 ± 0.09 g and pulpy pericarp encloses a stony seed. Depending on the size of the fruit, pulp weighs 2.10 ± 0.04 g whereas the seed weighs 1.47 ± 0.07 g.

E. serratus is one of the underutilized fruit species in India and is found and used extensively in West Bengal as Jalpai, Assam as Zolphai and Manipur as Chorphon. The consumption of this fruits has become increasingly important due to their potential health effects. Although, it is underutilized fruit species, they have potential for contribution to food security, health and nutrition, income generation and environmental services **(Pushpakumara *et al.*, 2007).** The ripened fruits stand out not only for its unique sour-bitter taste but also for its amazing nutritional and medicinal properties. In folk medicine, various parts of this plant have been extensively used in the treatment of stress, anxiety, depression, nerve pain, epilepsy, migraine, lack of concentration, asthma, hypertension, arthritis, and liver diseases. Apart from raw consumption of fruit, the fruit pulp is used for the preparation of value-added products such as jam, jelly, candy, pickle, and cider/wine.

Being an underutilized fruit, many fruits are wasted as there is little knowledge about postharvest management of this fruit. Since it yields several useful items including quality fodder, firewood and edible fruits, proper study on this fruit could minimize its wastage and maximize income generation.

Food processing is an important method to minimise postharvest loss and improve linkages between industry and agriculture. The loss can be minimised by converting the surplus food into various value-added products, like fermented and unfermented beverages. Fermentation is a potential tool in the development of new products from fruits with modified physio-chemical and sensory qualities, especially flavour and nutritional components (Dubey, 2002).

In most of the world, cider is an alcoholic beverage that is the result of fermentation made from pressed apple juice, effectively following the same process as wine. Most cider production processes rely on various strains of Saccharomyces cerevisiae that allow rapid and reliable fermentation, reduce the risk of sluggish or stuck fermentation, and prevent microbial contamination (Romano et al., 2003). Yeasts are the prominent organisms involved in cider production and determine several characteristics of the cider, including the flavour, through a

range of mechanisms and activities (Fleet, 2003).

Fermentation of cider and fermentation of wine are similar mechanisms. Alcoholic fermentation is characterised by the conversion of sugar into ethanol by yeast, especially the Saccharomyces cerevisiae strain of fungi used for alcoholic fermentation. The yeast eats all the sugar inside the vat of cider and turns it into alcohol and carbon dioxide. Once the whole sugar inside the cider is converted, the yeast dies due to a lack of food, and fermentation is stopped. Temperature is the most important factor for the fermentation process; temperatures ranging from 4 to 16°C are beneficial for cider making. After the completion of fermentation, the fermented cider is made, which contains about 4 to 6 percent alcohol. Before a second fermentation, the addition of sugar or extra fruit juice increases the ethanol content of the beverage and improves the quality of the cider.

Cider is a pleasant, refreshing, thirst-quenching, and hygienic beverage. It is also the most nutritive and health-giving of all fermented drinks. Besides, it is said to possess remarkable therapeutic properties, like the prevention of stone formation in the bladder on account of its diuretic properties (Chaudhary, 1969).

Elaeocarpus serratus L. cider, being a fruit-based fermented and undistilled product, contains most of the original nutrients present in it. Apart from the original nutrients, the nutritive value of Indian olive cider is increased due to the release of amino acids and other nutrients from the yeast during fermentation. Depending on the alcohol content, 1-5 percent of cider is considered soft cider, and 7-12 percent is considered hard cider. Research shows that Indian olive cider is nutraceutical in nature, curing various ailments naturally. It is rich in antioxidants, which delay the ageing of cells, cure diabetes and insomnia, act as anti-inflammatory agents, and reduce the risk of cardiovascular diseases, cancer, Parkinson's, and Alzheimer's diseases. Therefore, an experiment has been carried out with the aim of studying the effect of yeast and different levels of sugar on the physio-chemical properties and quality of Indian olive cider and estimating the economics of various treatments.

MATERIALS AND METHODS

The study was conducted in Completely Randomized Design (CRD) with 8 treatments replicated thrice. The treatments were T1 (Indian olive 500g +250ml water +150g sugar), T2 (Indian olive 500g +250ml water +200g sugar), T3 (Indian olive 500g +250ml water +250g sugar), T4 (Indian olive 500g +250ml water +300g sugar), T5 (Indian olive 500g +250ml

water +150g sugar +1.5g yeast), T6 (Indian olive 500g +250ml water +200g sugar +1.5g yeast), T7 (Indian olive 500g +250ml water +250g sugar +1.5g yeast) and T8 (Indian olive 500g +250ml water +300g sugar +1.5g yeast).

Raw Materials and Preparation of Cider

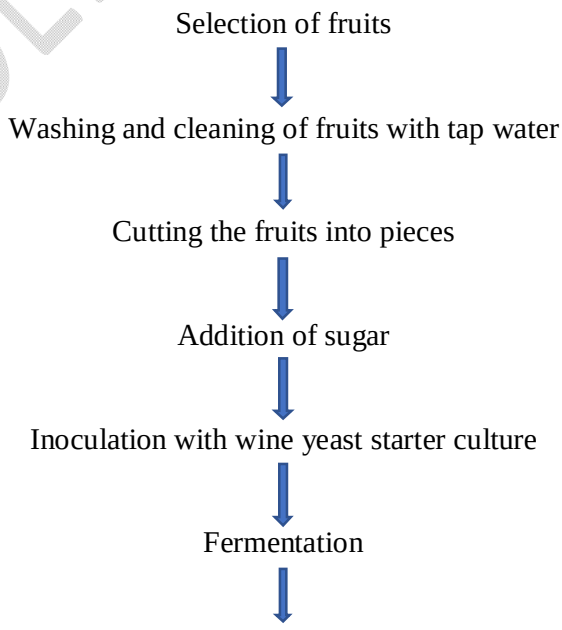
The fresh and ripened fruit of Indian olive was procured from Nungshong village of Ukhrul district, Manipur. The fruits that are free from diseases and pest were selected. Completely rotten fruits were discarded and rotten part of the fruits were removed. The selected fruits were washed thoroughly in a clean tap water to remove dust, dirt and other undesired materials adhering to the fruits. The selected fruits were cut into pieces with a stainless knife and 250 ml of water was added in all the treatments. The "must" was sieved using muslin cloth of pore size 0.8 mm.

Yeast and Inoculum Preparation

Saccharomyces cerevisiae was obtained from local market. The inoculum was prepared by inoculating 1.5 g brewer's yeast was added in 10 ml of lukewarm water in a beaker and stirred gently. The activated yeast was added to the pulp for further fermentation.

Preparation of Cider

Cider was prepared with different concentration of sugar. Steps of preparation are given below



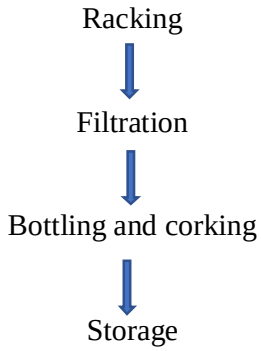


Fig.1 Flowchart of Indian olive cider preparation

Table 1. Meteorological data during experimental period (January 2023- Mach 2023)

Months	Time span	Temperature (ºC)		Relative humidity (%)		Rainfall (mm)
		Max	Min	Max	Min	
January	1st week	25	5.4	97	57	0
	2nd week	24.6	5.2	97	47	0
	3rd week	23.6	6	92	56	0
	4th week	28.4	7.6	95	49	8.2
February	1st week	25.2	10	88	38	0
	2nd week	30.2	13.2	84	37	0
	3rd week	31	13.6	83	42	0
	4th week	34.2	14.2	78	39	0
March	1st week	35.2	13.2	78	37	0
	2nd week	35.6	13.6	80	38	0
	3rd week	33.2	13	85	39	18.2
	4th week	35.2	16.2	84	37	0

Determination of Physio-Chemical Parameters

The physio-chemical changes that the cider underwent during production and storage were examined. The must pH was determined using AOAC, (2004) procedure where a digital pH

meter was used to determine the product's pH, while a hand-held refractometer was used to measure TSS and the results were expressed as degree brix (ºB) (AOAC, 2000), titratable acidity was measured by using phenolphthalein as an indicator (AOAC, 2000) to titrate 10 ml of an aliquot against a standard solution of 0.1 N NaOH. Appearance of light pink color was taken as an end point, and a hydrometer was used to measure alcohol content and specific gravity (Triple scale Hydrometer). The product was also examined for color and appearance, taste, aroma, and overall acceptability using a 9-point Hedonic scale with a panel of 5 experts.

RESULTS AND DISCUSSIONS

The experiment entitled “Effect of yeast and different levels of sugar on Indian olive (*Elaeocarpus serratus* L.) cider” was undertaken in the Post-Harvest Laboratory, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during the year 2022-2023. The results of the investigation regarding production of cider from Indian olive have been presented here (Tables 2 to 4).

Completely randomized block design (CRBD) by Panse and Sukhtme's analysis of variance (ANOVA) approach was used for the statistical analysis. Using the critical difference (C. D. at 5%) threshold of significance, the overall significance of differences between treatments was examined. A window-based computing tool called OPSTAT was used to statistically analyse the results (Sheoran, 2004).

Total Soluble Solids (ºBrix)

Changes in TSS of Indian olive cider during fermentation is presented in Table 2. Total soluble solids of cider, at the end of fermentation period is an important quality parameter and an indicative of the stability and completeness of fermentation. The statistical analysis has showed that there were significant differences in the TSS of all the treatments during 90 days storage. The total soluble solids content on Indian olive cider showed decreasing trend in all the treatments. It is possible that the fermentation of sugars into alcohol by the action of yeast during storage is what caused the decrease in total soluble solids content of Indian olive cider. The general decrease in TSS was a function of time and was undoubtedly caused by the yeast fermenting the sugar. This is typical cider fermentation behavior for any alcoholic fruit juice fermentation. The decrease in TSS content of cider indicates the conversion of sugar into alcohol by yeast during fermentation. The results found are similar with the findings of

(Idise *et al.*, 2010) in pomegranate wine and **(Isitua *et al.*,2010)** in banana wine. The maximum score (29.86) of TSS (°brix) was observed in treatment T8 (500g Indian olive + 250ml water +300g sugar +1.5g yeast) and lowest score (5.5) was observed in treatment T5 (500g Indian olive + 250ml water +150g sugar +1.5g yeast).

pH

The statistical analysis has showed that there were significant differences in pH during 90 days storage. As fermentation time increased, the pH steadily decreased. The changes in pH are due to the effect of yeast strain and fermentation time. **(Dhakane *et al.*, 2016)** encoded that low pH contributes to the stability of alcoholic beverages over time. The decrease in pH with increase in acidity of cider may be due to the formation of hydrogen ions by the action of yeast. The results shown are similar with the findings of **(Won *et al.*, 1993)**; **(Sigler *et al.*, 1981)** and **(Castrillo *et al.*, 1995).** The lowest score of pH (3.21) was found in treatment T5 (500g Indian olive + 250ml water +150g sugar +1.5g yeast) whereas the maximum score (4.69) was found in treatment T8 (500g Indian olive + 250ml water +300g sugar +1.5g yeast).

Titratable Acidity (%)

when the pH dropped, it was discovered that the titratable acidity increased, indicating that more organic acids were being generated as the microbes used the substrates. Acidity plays a vital role in determining cider quality by aiding the fermentation process and enhancing the overall characteristics and balance of the cider. Lack of acidity will mean a poor fermentation **(Berry, 2000).** Titratable acidity increased as fermentation progressed. During the storage period of 90 days as shown in Table 2, the increasing in acidity of Indian olive cider may possibly be due to production of certain organic acid such as citric, mucic and tartaric acids by yeast. The results shown are similar with the findings of **(Ngaihlhing, 2023)** in pomegranate cider. The lowest score (0.35) of acidity (%) was observed in treatment T7 (500g Indian olive + 250ml water +250g sugar +1.5g yeast) and maximum score (0.83) was observed in treatment T5 (500g Indian olive + 250ml water +150g sugar +1.5g yeast).

Alcohol content (%)

With the increase in fermentation time, alcohol concentration also increases. During 90 days storage as shown in Table 2, the increase in alcohol content of Indian olive cider with yeast and different levels of sugar during storage may be possibly due to the variation in

performance of the sugar affecting the ferment ability, hence the varied alcohol production. The results shown are similar with the findings of **(Wanapu *et al.*, 2004)** in rose apple cider, **(Beera *et al.*, 2013)** in banana wine. The highest score (10.72) of alcohol content (%) was found in treatment T5 (500g Indian olive + 250ml water +150g sugar +1.5g yeast) and the lowest score (4.57) was found in treatment T8 (500g Indian olive + 250ml water +300g sugar +1.5g yeast).

Specific Gravity

As shown in Table 2, the specific gravity decreases as the fermentation time of cider increases. The decrease in specific gravity of Indian olive cider during storage may be possibly due to concentration yeast used and different levels of sugar in the cider production. It is also reported that *Saccharomyces cerevisiae* reduces specific gravity of fruit juices during fermentation. The results found are similar with the findings of **(Jarvis, 2014)** in apple cider, and **(Yadav *et al.*, 2009)** in Mahua wine. The lowest score (1.021) of specific gravity was observed in treatment T5 (500g Indian olive + 250ml water +150g sugar +1.5g yeast) and the maximum score (1.128) was observed in treatment T8 (500g Indian olive + 250ml water +300g sugar +1.5g yeast).

Organoleptic Evaluation

As shown in Table 3, the highest sensory scores for organoleptic evaluation such as color and appearance, aroma, taste, and overall acceptability was observed in treatment T6 (500g Indian olive + 250ml water +200g sugar +1.5g yeast) with 8.14, 8.20, 8.69 and 8.43 which indicates the judges approved of it.

Table 2. Physio-chemical parameters of Indian olive cider during storage

Treatment symbols	Treatment details	Total Soluble Solids (°Brix)				pH				Acidity (%)				Alcohol (%)			Specific Gravity			
		Initial	30DAS	60DAS	90DAS	Initial	30DAS	60DAS	90DAS	Initial	30DAS	60DAS	90DAS	30DAS	60DAS	90DAS	Initial	30DAS	60DAS	90DAS
T1	Indian olive + water + 150 g Sugar	19.2	12.33	8.3	6.23	4.39	4.31	4.03	3.36	0.51	0.62	0.7	0.74	6.83	9.01	10.57	1.071	1.051	1.032	1.024
T2	Indian olive + water + 200 g Sugar	20.36	13.33	9.21	6.86	4.43	4.4	4.13	3.57	0.47	0.54	0.62	0.69	6.3	8.74	10.45	1.084	1.054	1.037	1.027
T3	Indian olive + water + 250 g Sugar	23.13	14.47	9.76	7.46	4.64	4.45	3.95	3.37	0.44	0.5	0.53	0.61	4.78	7.74	8.71	1.097	1.059	1.038	1.029
T4	Indian olive + water + 300 g Sugar	26.96	17.26	10.86	7.73	4.67	4.47	4.12	3.66	0.36	0.46	0.51	0.55	4.55	6.73	7.53	1.116	1.071	1.044	1.031
T5	Indian olive + water + 150 g Sugar +1.5 g yeast	15.53	10.3	7.8	5.5	4.35	4.21	3.79	3.21	0.56	0.63	0.73	0.83	7.49	9.56	10.72	1.063	1.04	1.031	1.021
T6	Indian olive + water + 200 g Sugar +1.5 g yeast	50.6	12.56	8.43	6.36	4.61	4.42	4.08	3.43	0.48	0.56	0.61	0.64	6.43	8.62	9.69	1.084	1.051	1.032	1.024
T7	Indian olive + water + 250 g Sugar +1.5 g yeast	28.93	19.1	13.7	10.56	4.62	4.41	4.1	3.45	0.35	0.42	0.49	0.56	4.47	6.56	7.68	1.124	1.071	1.055	1.042
T8	Indian olive + water + 300 g Sugar+1.5 g yeast	29.86	20.5	14.56	12.36	4.69	4.44	4.11	3.81	0.43	0.45	0.48	0.53	4.57	6.42	7.35	1.128	1.081	1.058	1.05
F-test		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
SE.(d)		0.289	0.172	0.149	0.139	0.067	0.61	0.54	0.52	0.01	0.009	0.009	0.009	0.14	0.09	0.069	0.002	0.001	0.001	0.001
CD at 0.5%		0.617	0.367	0.319	0.298	0.144	0.13	0.115	0.11	0.021	0.019	0.02	0.02	0.3	0.192	0.147	0.004	0.002	0.002	0.001
CV		1.532	1.218	1.653	2.665	1.442	1.811	1.848	1.888	2.713	2.089	1.981	1.736	3.024	1.385	0.928	1.19	0.097	0.069	0.101

*In all treatments 500g Indian olive fruit and 250ml of water was used uniformly

Table 3. Organoleptic score of Indian olive cider during storage

Treatment symbols	Treatment details	Colour and appearance			Aroma			Taste			Overall acceptability		
		30 DAS	**60 DAS**	**90 DAS**	**30 DAS**	**60 DAS**	**90 DAS**	**30 DAS**	**60 DAS**	**90 DAS**	**30 DAS**	**60 DAS**	**90 DAS**
T1	Indian olive + water + 150 g Sugar	5.11	5.84	6.73	5.73	6.13	6.69	6.08	6.38	6.97	6	6.45	7.13
T2	Indian olive + water + 200 g Sugar	5.4	6.65	7.6	6.22	6.72	7.63	6.52	7.25	7.84	6.02	6.5	7.66
T3	Indian olive + water + 250 g Sugar	4.78	5.69	6.15	5.27	5.75	6.61	5.42	5.81	6.28	5.76	5.94	6.82
T4	Indian olive + water + 300 g Sugar	4.28	5.61	5.98	5.14	5.47	6.25	4.77	5.12	5.64	4.83	5.08	6.58
T5	Indian olive + water + 150 g Sugar +1.5 g yeast	6.28	7.81	8.19	6.79	7.14	7.61	6.28	7.62	8.14	6.64	6.92	7.93
T6	Indian olive + water + 200 g Sugar +1.5 g yeast	6.38	7.85	8.14	7.13	7.61	8.2	6.59	8.18	8.69	7.22	7.64	8.43
T7	Indian olive + water + 250 g Sugar +1.5 g yeast	5.71	6.72	7.68	5.95	6.2	6.75	6.11	6.9	7.21	6.58	7.11	7.72
T8	Indian olive + water + 300 g Sugar+1.5 g yeast	5.51	6.28	6.62	5.4	5.89	6.49	5.56	6.2	6.71	5.54	6.19	6.72
F-Test		**S**	**S**	**S**	S	S	S	S	S	S	S	S	S
SE.(d)		0.044	0.060	0.032	0.041	0.026	0.031	0.066	0.031	0.025	0.078	0.030	0.025
CD at 0.5%		0.094	0.129	0.032	0.088	0.055	0.067	0.141	0.066	0.054	0.166	0.165	0.053
CV		0.995	1.125	0.545	0.851	0.495	0.548	1.361	0.570	0.427	1.565	0.576	0.412

*In all treatments 500g Indian olive fruit and 250ml of water was used uniformly

Table 4. Economics of different treatments and benefit ratio of Indian olive cider

Treatment no.	Treatment details	Total cost (Rs)	Cider output	Selling rate (Rs/bottle)	Gross return (Rs)	Net return (Rs)	Benefit cost ratio
T1	Indian olive + water + 150 g Sugar	189.17	3	260	780	212.5	1.44
T2	Indian olive + water + 200 g Sugar	191.67	3	270	810	234.9	1.41
T3	Indian olive + water + 250 g Sugar	194.17	3	250	750	167.5	1.29
T4	Indian olive + water + 300 g Sugar	196.67	3	220	660	69.9	1.11
T5	Indian olive + water + 150 g Sugar +1.5 g yeast	195.92	3	290	870	282.2	1.48
T6	Indian olive + water + 200 g Sugar +1.5 g yeast	198.42	3	300	900	304.7	1.51
T7	Indian olive + water + 250 g Sugar +1.5 g yeast	200.92	3	280	840	237.2	1.39
T8	Indian olive + water + 300 g Sugar+1.5 g yeast	203.42	3	230	690	79.7	1.13

*In all treatments 500g Indian olive fruit and 250ml of water was used uniformly

CONCLUSION

Based on findings of the present investigation it is concluded that treatment T5 (Indian olive 500g + 250ml water + 150g sugar + yeast 1.5g) was found superior in terms of Total Soluble Solids (5.50 □Brix), pH (3.21), Acidity (0.83%), Alcohol (10.72%) and Specific gravity (1.021). Whereas, in terms of Colour and appearance (8.19), Aroma (8.20) Taste (8.69), and Overall acceptability (8.43), treatment T6 (Indian olive 500g +250ml water +200g sugar +1.5g yeast) was found superior. Similarly, treatment T6 showed the highest BC ratio (1.51).

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