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PHYSICO-CHEMICAL PROPERTIES AND ECONOMICS OF AONLA (*EMBLICA OFFICINALIS*) WINE AS AFFECTED BY DIFFERENT CONCENTRATIONS OF SUGAR

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Abstract–The present research work entitled "Physico-chemical properties and economics of Aonla wine (*Emblica officinalis*) as effect by different concentration of sugar" was undertaken in the Post-Harvest Laboratory, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during the year 2020- 2021. There were eight treatments under observation they are T_1 Aonla juice (3000 ml) + Yeast (2 g) + Sugar (350 g), T_2 Aonla juice (3000 ml) + Yeast (2 g) + Sugar (450 g), T_3 Aonla juice (3000 ml) + Yeast (2 g) + Sugar (550 g), T_4 Aonla juice (3000 ml) + Yeast (2 g) + Sugar (650 g), T_5 Aonla juice (3000 ml) + Yeast (2 g) + Sugar (750 g), T_6 Aonla juice (3000 ml) + Yeast (2 g) + Sugar (850 g), T_7 Aonla juice (3000 ml) + Yeast (2 g) + Sugar (950 g), T_8 Aonla juice (3000 ml) + Yeast (2 g) + Sugar (1050 g). The experiment was laid out in CRD (Complete Randomized Design) with 8 treatments replicated thrice. The treatment combination mentioned above was added to each treatment with 3 replication each. Here attempt of preparation of wine were done and its physical and sensory quality was evaluated to determine its suitability. Analysis revealed that the sensory quality was increased when the treatment T_7 Aonla juice (3000 ml) + Sugar 950 g + Wine Yeast (2g) was used for wine preparation. The treatment T_7 Aonla juice (3000 ml) + Sugar (950 g) + Wine Yeast (2g) was found superior in respect of the parameters like Total Soluble Solids, Acidity, pH, Alcohol content, Specific gravity. With respectively Colour and Appearance, Taste, Aroma and Overall acceptability also T_7 was found best.

INTRODUCTION

Wine is an alcoholic beverage typically made up of fermented fruit juice. It is the oldest alcoholic beverage that has been discovered, dating back to at least 5000 B.C. It has a long history of being connected to human artistic, cultural and religious endeavours.. Wine has been produced first among alcoholic beverages and has been utilised as a food additive. Additionally, it has a lengthy history of use as a medication. It has been utilised as a medicinal agent and by enhancing contentment, as a crucial addition to the human diet.

There has been a lot of research done on many elements of creating wine from various fruits, which is an ancient practise in many nations. The fruit's kind and makeup heavily influence its personality and quality. Fruit wines are alcoholic beverages that are not distilled and are therefore tastier, healthier and milder stimulants. The extraction of components of Aonla into wine, offers a highly valued health drink. In this regard alcoholic fermentation and extraction of Aonla compounds into wine and the effect of different concentrations of sugar on extractability of Aonla compounds is attempted.

Wine has been used as food and medicine since ages. The excess consumption of wine however, causes severe depression in coordination of movements and loss of consciousness. Functional or health-enhanced foods include "those in which the concentrations of one or more ingredients have been manipulated or modified to enhance their contribution to a healthy diet. The functional interest in wine, particularly red wine can be traced to the term "French paradox" referring to the observation that French people consume a high saturated fat diet, but their mortality rate from

coronary heart disease is low because of high wine consumption.

Aonla (*Emblica officinalis Gaertn.*) also called as Amla, Indian gooseberry. Aonla is a subtropical fruit belonging to family Euphorbiaceae. It is extensively used in Ayurveda for its medicinal properties, since time immemorial. It is a rich source of vitamin-C, contain 1, 3, 6-trigalloylglucose, terchebin, corilagin, ellagic, phyllenblic acids, alkaloids like phyllantidine and phyllantine.

An alternative method of processing like fermentation is boon in this regard. Further, to ward off misconception regarding drinking alcohol beverages, developments of products which are having less than 5 per cent alcohol using natural source of sugar, which is similar to many Ayurveda products, helps in better acceptance of the prepared products for enhanced health benefits. Therefore, blending of two or more fruit juices and their beverages are thought to be a convenient alternative for its utilization in order to have some value added fruit drinks which are of high quality in respect of sensory and nutritional aspects. So the preparation of blended beverage Aonla as the present technology of manufacturing wine from grapes is available. The extraction of components of aonla into wine, offers a highly valued health drink. In this regard alcoholic fermentation and extraction of Aonla compounds into wine and the effect of different concentrations of sugar on extractability of aonla compounds is attempted.

MATERIALS AND METHOD

The present research work entitled "Physio-chemical properties and economics of Aonla wine (*Emblica officinalis*) as effect by different concentration of sugar" was undertaken in the Post-Harvest Laboratory, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during the year 2021- 2022. It consisted of 8 treatments and 3 replications each. Eight treatment combinations viz.T_1 Aonla juice (3000 ml) + Yeast (2 g) + Sugar (350 g), T_2 Aonla juice (3000 ml) + Yeast (2 g) + Sugar (450 g) , T_3 Aonla juice (3000 ml) + Yeast (2 g) + Sugar (550 g) , T_4 Aonla juice (3000 ml) + Yeast (2 g) + Sugar (650 g) , T_5 Aonla juice (3000 ml) + Yeast (2 g) + Sugar (750 g) , T_6Aonla juice (3000 ml) + Yeast (2 g) + Sugar (850 g) , T_7Aonla juice (3000 ml) + Yeast (2 g) + Sugar (950 g) , T_8 Aonla juice (3000 ml) + Yeast (2 g) + Sugar (1050 g), were applied during the research work. The treatments were allocated in Completely Randomized Design (CRD) for each of the replication. The Aonla wine was analyzed for the following quality parameters during fermentation and storage. In order to judge the suitability of Aonla fruit in preparation of wine, it is necessary to have a closer look on its physico- chemical composition. The observations were recorded as T.S.S (%Brix), Titratable acidity (%), pH, Alcohol content (%), Specific gravity, Colour and Appearance, Taste, Aroma, Overall acceptability.

The Aonla, fresh, ripe and matured were purchased from Horticulture Research Farm, SHUATS, Prayagraj on 10th December 2021, stored at room temperature. At its optimum and wholesome stage for wine production the fruits were washed, weighed and must prepared from it. On processing was started 11th December 2022. Commercial wine yeast *Saccharomyces cerevisiae* used in fermentation was obtained from vinsura winery Pvt. Ltd, lasalgaon Nashik, Mumbai. Lastly, most of the equipment's used were supplied from the University laboratory.

The fruits were selected and washed with tap water, sliced and cut into pieces and added water. The slurry was further diluted in a ratio of 1:2 and sieved with a muslin cloth of pore size 0.8 mm to obtain the filtrate "must". Chaptalization and supplementation of the "Must". The methods of Amerine and Kunkee as used by Robinson were used. These bottled juices were cold stored till further experiments were conducted. Bottles were washed thoroughly with hot water and kept it for sun dry and sterilized. The yeast starter culture was prepared from a known quantity of must for fermentation, small quantity of sugar, yeast and a known volume of water. The mixture of all these were treated and allowed to stand for 24 hr. Approximately 200 ml of water was boiled and allowed to attain 37 °C and 200 ml of the mixture of aonla must respectively treated with sugar was added. Exactly 3.7 ml representing approximately 108 cfu/ml (measured using McFarland standard) of the yeast (*S. cerevisiae*) after centrifugation was added to the mixture, stirred properly and allowed to stand for 24 hr. before use. The following parameters were monitored before and during fermentation process are; Specific gravity, pH, Titratable acidity, Total soluble solid and Alcohol content. The primary fermentation was initiated by the addition of the starter culture. The must was stirred every 12 hr. with subsequent reading of the

specific gravity, pH, temperature and alcohol content for 4 days. After 4 days, the wine was racked into the secondary fermenter. The secondary fermentation was done in an air tight container in which a tube was passed into a clean bottle containing clean water. The essence was to monitor the course of fermentation. This was allowed until completion of fermentation as was evidenced by lack of the appearance of bubbles in the container usually within 3 weeks. Secondary fermentation was done for 21 days. When fermentation stopped, the wine was promptly racked off the lees ensuring minimum exposure to oxygen, the upper liquid was transfer to the other clean container in order to remove impurities. Then the mixture continued to ferment at 20 °C for more days. After that, under the storage conditions of 20°C aged 3 months. Microbial analysis, alcohol, sugar content, specific gravity, titratable acidity and pH of the wine were also monitored at the end of the secondary fermentation. After completion of fermentation, the obtained wine was siphoned off and filtered through a clean sterilized muslin cloth, Whatman No.1 filter paper and sieve and syphon tubes sterilized by 70 % alcohol and collected in sterile glass jars. The wine was racked for a period of 3 weeks to clear the wine. The residues were removed and the filtrates were allowed to mature before other chemical analysis was carried out. Clarification is an important procedure in wine production as the fermented wine contains sediments. After clarification, the wine was kept in the refrigerator for maturation (2 weeks) and then packaged for further analysis. Wine ageing and its ability to potentially improve wine quality for its consumption is most important step after wine production. After maturation, the supernatant was taken off and transferred into fresh sterile bottles, corked and subjected for pasteurization at 82 °C for 20 minutes. After cooling, further allowed to age in 1000 ml glass bottles for 17 days at 22-25 °C before analysis. The wine was analyzed for physio- chemical properties at 30 days interval after 30 days from fermentation, i.e., 30, 60, 90 days. Wines were also evaluated organoleptically after maturation with panel of judges for knowing the acceptance by different categories of consumers.

RESULTS AND DISCUSSION

Changes in TSS

Total soluble solids of wine, at the end of fermentation period, is an important quality parameter and an indicative of the stability and completeness of fermentation. The lowest score of TSS (13.63°, 13.29°, 11.24° and 6.84° Brix) was observed in treatment T_1 Aonla juice (3000 ml) + Sugar (350 g) + Yeast (2 g), followed by treatment T_2 Aonla juice (3000 ml) + Sugar (450 g)+ Yeast (2g) with (15.02°, 14.51°, 12.25° and 8.27° Brix), whereas the maximum score was observed in treatment T_8 Aonla juice (3000 ml) + Sugar (1050 g) + Wine yeast (2 g) with (19.11°, 18.3°, 16.15° and 12.51° Brix) at initial, 30, 60 and 90 days storage. The total soluble solids content of Aonla wine was showed decreasing trend in all Aonla wine during storage. The decrease in total soluble solids content of Aonla wine with different levels of wine yeast and sugar during storage may possibly be due to fermentation of sugars into alcohol by the action of yeast. In general, reduction in TSS was a function of time and was evidently due to the fermentation of sugar by the yeast. The above results are similar with the findings of Akubor *et al*., (2003), Isitua and Ibeh (2010) and Jadhav *et al.* (2016).

Changes in Alcohol (%)

The highest score of Alcohol content (5.24, 7.60 and 10.35) was observed in treatment T_2 Aonla juice (3000 ml) + Sugar (450 g) + Wine yeast (2 g) followed by treatment T_5 Aonla juice (3000 ml) + Sugar 850g+ Wine yeast 2 g) with (4.31, 6.32 and 8.18), whereas the minimum score was observed in treatment T_3 Aonla juice (3000 ml) + Sugar (550 g) + Wine yeast (2 g) with (2.78, 5.03 and 7.02) at 30, 60 and 90 days storage. The trend of alcohol increase or TSS fall during fermentation was similar to the fermentation behavior of any fruit to make wine. The increase in Alcohol content of Aonla wine with different levels of wine yeast and sugar during storage may possibly due to the variation in performance of the yeast to utilize the fermentable sugars affecting the ferment ability, hence the varied alcohol production. The above results are similar with the findings of Chowdhury and Ray (2007), Idise (2011) and Kiin *et al*., (2019).

Changes in Acidity (%)

The lowest score of Acidity (0.36,0.42, 0.51 and 0.58) was observed in treatment T_7 Aonla juice (3000 ml) + Sugar 950 g + Wine yeast 2g), followed by treatment T_6 Aonla juice (3000 ml) + Sugar (850 g) + Wine yeast (2 g) with (0.39,0.42, 0.52 and 0.61), whereas the maximum score was observed in treatment T_1 Aonla juice (3000 ml) + Sugar (350 g) +

Wine yeast (2g) with (0.66, 0.74 and 0.87) at initial, 30, 60 and 90 days storage. The increase in Acidity of Aonla wine with different levels of wine yeast and sugar during storage may possibly be due to the effect of different yeast strain and fermentation period. The above results are similar with the findings of Kumar *et al.* (2009) and Reddy *et al*. (2010).

Changes in pH

The lowest score of pH (4.45,4.37, 4.04 and 3.90) was observed in treatment T_7 Aonla juice (3000 ml) + Sugar (950 g) + Wine yeast (2 g) followed by treatment T_4 Aonla juice (3000 ml) + Sugar (650 g) + Wine yeast (2 g) and T_8Aonla juice (3000 ml) + Sugar (1050 g) + Wine yeast (2 g) with (4.91,4.75, 4.63 and 4.07) and (4.79,4.52,4.27 and 4.07) respectively, whereas the maximum score was observed in treatment T_1 Aonla juice (3000 ml) + Sugar (350 g) + Wine yeast (2 g) with (6.09,6.02, 5.70 and 5.58) at initial, 30, 60 and 90 days storage. Variation observed was due to the effect of different yeast strain and fermentation period. Studies have shown that during fermentation of fruits, low pH is inhibitory to the growth of spoilage organisms but create conducive environment for the growth of desirable organisms. Also, low pH and high acidity are known to give fermentation yeast comparative advantage in natural environments. The above results are similar with the findings of Kiin *et al*. (2019).

Specific Gravity

The lowest score of Specific gravity (1.26,1.12 and 0.93) was observed in treatment T_6 Aonla juice (3000 ml) + Sugar (850 g) + Wine yeast (2 g) followed by treatment T_7 Aonla juice (3000 ml) + Sugar (950 g) + Wine yeast (2 g) with (1.39, 1.19 and 0.99) , whereas the maximum score was observed in treatment T_3Aonla juice (3000 ml) + Sugar (550 g) + Wine yeast (2g) with (1.45, 1.31 and 1.17), at 30, 60 and 90 days storage. The specific gravity of the Aonla wine produced in this study reduces as the fermentation days of the wine increases. The decrease in Specific

Table 1. Effect of different concentration of sugar on the T.S.S and Specific gravity during storage.

Treatments	TSS (°Brix)				Specific gravity			
	Initial	30 days	60 days	90 days	Initial	30 days	60 days	90 days
T_1	11.24	9.45	8.75	6.84	1.41	1.39	1.3	1.14
T_2	12.25	11.23	10.21	8.27	1.39	1.35	1.23	1.09
T_3	12.8	10.17	9.88	7.75	1.49	1.45	1.31	1.17
T_4	13.46	12.51	11.63	9.01	1.47	1.4	1.28	1.1
T_5	14.16	12.52	10.02	9.37	1.42	1.35	1.22	1.09
T_6	14.82	12.54	11.15	10.25	1.45	1.39	1.19	0.93
T_7	15.3	13.06	12.18	10.52	1.32	1.26	1.12	0.99
T_8	15.45	14.76	12.76	11.51	1.41	1.38	1.25	1.04
F-Test	S	S	S	S	S	S	S	S
S.Ed. (+)	0.27	0.19	0.02	0.04	0.06	0.04	0.03	0.03
C.D. at 5%	0.58	0.40	0.04	0.08	0.13	0.10	0.06	0.07

Table 2. Effect of different concentration of sugar on Alcohol content, Acidity (%) and pH during storage.

Treatment	Alcohol content			Acidity (%)				pH			
	30 days	60 days	90 days	Initial	30 days	60 days	90 days	Initial	30 days	60 days	90 days
T_1	2.78	5.03	7.02	0.56	0.66	0.74	0.87	6.09	6.02	5.7	5.58
T_2	3.6	5.62	7.18	0.49	0.52	0.61	0.69	5.68	5.72	5.16	4.47
T_3	3.17	5.82	7.87	0.58	0.62	0.74	0.83	5.10	5.41	5.02	4.63
T_4	3.35	6.19	7.97	0.53	0.58	0.64	0.75	4.91	4.75	4.63	4.07
T_5	4.21	6.32	8.18	0.59	0.64	0.73	0.83	4.59	4.73	4.2	3.93
T_6	4.31	6.52	8.19	0.39	0.42	0.52	0.61	5.27	5.19	4.92	4.26
T_7	4.39	6.88	8.27	0.36	0.42	0.51	0.58	4.45	4.37	4.04	3.9
T_8	5.24	7.6	10.35	0.51	0.55	0.62	0.74	4.79	4.52	4.27	4.07
F-Test	S	S	S	S	S	S	S	S	S	S	S
S.Ed. (±)	0.09	0.09	0.18	0.06	0.03	0.03	0.03	0.20	0.12	0.12	0.10
C.D. at 5%	0.19	0.20	0.38	0.12	0.06	0.07	0.06	0.43	0.26	0.27	0.22

gravity of Aola wine with different levels of sugar during storage may possibly be due to the type of yeast used in the wine production. The above results are similar with the findings of Umashankar *et al.* (2014) and Jadhav *et al.* (2016).

Sensory Evaluation

The maximum score of colour and appearance (7.84, 8.28 and 8.81) was observed in treatment T_7 Aonla juice (3000 ml) + Sugar (950 g) + Wine yeast (2 g), followed by treatment T_8 Aonla juice (3000 ml) + Sugar (1050 g) + Wine yeast (2 g) with (7.55, 7.82 and 8.08) whereas the minimum score was observed in treatment T_3 Aonla juice (3000 ml) + Sugar (550 g) + Wine yeast (2 g) with (3.57, 4.19 and 4.75) at 30, 60 and 90 days storage. In terms of Taste, the maximum score of Taste (7.44, 7.78 and 8.13) was observed in treatment T_7 Aonla juice (3000 ml) + Sugar (950 g) + Wine yeast (2 g) followed by treatment T_8 Aonla juice (3000 ml) + Sugar (1050 g) + Wine yeast (2 g) with (7.19, 7.41 and 7.96) whereas the minimum score was observed in treatment T_3 Aonla juice (3000 ml) + Sugar (550 g) + Wine yeast (2 g) with (4.05, 4.48 and 4.84) at 30, 60 and 90 days storage.

In terms of Aroma, the maximum score of Aroma (7.40, 7.77 and 8.02) was observed in treatment T_7 Aonla juice (3000 ml) + Sugar (950 g) + Wine yeast (2 g) followed by treatment T_8 Aonla juice (3000 ml) + Sugar (1050 g) + Wine yeast (2g) with (7.16, 7.34 and 7.86) whereas the minimum score was observed in treatment T_3 Aonla juice (3000 ml) + Sugar (550 g)+ Wine yeast (2 g) with (3.81, 4.06 and 4.23) at 30, 60 and 90 days storage. In terms of Overall acceptability, the maximum score of Overall acceptability (7.24, 7.53 and 8.03) was observed in treatment T_7 Aonla juice (3000 ml) + Sugar (950 g) + Wine yeast (2 g) followed by treatment T_8Aonla juice (3000 ml) + Sugar (1050 g) + Wine yeast (2g) with (6.94, 7.22 and 7.88) whereas the minimum score was observed in treatment T_3 Aonla juice (3000 ml) + Sugar (550g) + Wine yeast (2 g) with (3.86, 4.05 and 4.57) at 30, 60 and 90 days storage.

Table 3. Effect of different concentration of sugar on Colour and Appearance and Taste during storage.

Treatment	Colour and Appearance			Taste		
	30 days	60 days	90 days	30 days	60 days	90 days
T_1	4.25	4.97	5.26	4.3	4.79	5.11
T_2	5.48	5.92	6.24	5.58	5.82	6.19
T_3	3.57	4.19	4.75	4.05	4.48	4.84
T_4	4.64	5.05	5.44	4.73	4.96	5.14
T_5	6.02	6.19	6.57	5.82	6	6.17
T_6	5.68	6.02	6.35	6.11	6.42	6.77
T_7	7.84	8.28	8.81	7.44	7.78	8.13
T_8	7.55	7.82	8.08	7.19	7.41	7.96
F-Test	S	S	S	S	S	S
S.Ed. (±)	0.32	0.26	0.14	0.17	0.11	0.08
C.D. at 5%	0.69	0.55	0.29	0.36	0.24	0.18

Table 4. Effect of different concentration of sugar on Aroma and Overall acceptability during storage.

Treatment	Aroma			Overall acceptability		
	30 days	60 days	90 days	30 days	60 days	90 days
T_1	4.07	4.64	4.98	4.26	4.8	5.05
T_2	5.57	5.77	6.08	5.39	5.71	5.92
T_3	3.81	4.06	4.23	3.86	4.05	4.57
T_4	4.42	4.76	5.03	4.56	4.81	5.1
T_5	6	6.24	6.7	5.92	6.19	6.46
T_6	5.71	5.94	6.41	5.74	5.95	6.18
T_7	7.4	7.77	8.02	7.21	7.53	8.03
T_8	7.16	7.34	7.86	6.94	7.22	7.88
F-Test	S	S	S	S	S	S
S.Ed. (±)	0.13	0.08	0.07	0.07	0.05	0.08
C.D. at 5%	0.28	0.18	0.15	0.14	0.11	0.18

Economical Evaluation

In terms of Cost Benefit Ratio, The Cost Benefit Ratio showed that there were significant differences among all the treatments in Cost Net Return, Gross Return and Cost Benefit Ratio of different treatments. Maximum gross return was obtained in T_7Aonla juice (3000 ml) + Sugar (950 g)Wine yeast (2 g)+ and T_8 Aonla juice (3000 ml) + Sugar (950g) + Wine yeast (2 g) (Rs. 2400) respectively and minimum was found in T1 and T_2Aonla juice (3000 ml) + Sugar (350 g)+ Wine yeast (2g) Aonla juice (3000 ml) + Sugar (450 g)+ Wine yeast (2g) (Rs. 1800) respectively. Maximum net return was obtained in T_7 Aonla juice (3000 ml) + Sugar (950 g) + Wine yeast (2g) (Rs.1606.4) and T_8Aonla juice (3000 ml) + Sugar (1050 g) + Wine yeast (2 g) (Rs.1602.4) and minimum was found in T_1 Aonla juice (3000 ml) + Sugar (350 g) + Wine yeast (2 g) (Rs.1030) and T_2 Aonla juice (3000 ml) + Sugar (450 g) + Wine yeast (2g) (Rs.1026.4).

Maximum Benefit Cost ratio was obtained with treatment T_7 Aonla juice (3000 ml) + Sugar (950 g) + Wine yeast (2 g) (1:3.02) followed by T_8 Aonla juice (3000 ml) + Sugar (1050 g) + Wine yeast (2 g) (1:3.00) and minimum was found in T_2 Aonla juice (3000 ml) + Sugar (1050 g) + Wine yeast (2 g) (1:2.32) .

CONCLUSION

Based on findings of the present experiment it is concluded that treatment T_7Aonla juice (3000 ml) + Sugar (950 g) + Wine yeast (2 g) was found superior in respect of the parameters like Total Soluble Solids, Acidity, pH, Alcohol content, Specific gravity. With respectively Colour and Appearance, Taste, Aroma and Overall acceptability also T_7 was found best.

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