Environment and Ecology 41 (1) : 168—173, January—March 2023
ISSN 0970-0420

Effect of Sugar Sources on Nutrient Retention and Organoleptic Characteristics of Blood Fruit and Aonla Fermented Beverages During Storage

Rapunga Flory H, Arvind Kumar Chaurasiya

Received 10 September 2022, Accepted 23 October 2022, Published on 27 January 2023

ABSTRACT

Blood fruit and aonla are highly nutritious fruits, production of fermented beverage from this fruits could reduce post harvest loss and different variety of beverages can be produced. The aim of this study was to evaluate the response of different source of sugar (palm and cane jaggery) on production of blood fruit and aonla fermented beverages. From the finding it was observed that there was decrease in TSS, total sugar, ethyl alcohol, β-carotene, anthocyanin and ascorbic content during storage. Whereas, titratable acidity and organoleptic score increases after 14 months of storage. Maximum ethyl alcohol and organoleptic score, was obtained in fermented beverages using palm jaggery during storage with better β- carotene and anthocyanin retention percentage. Both the fermented beverages showed acceptable scores by the panellist so can be recommended for the commercial production and generate employment.

Keywords Bloodfruit, Aonla, Jaggery, Fermented beverages.

Rapunga Flory H.[1]*, Arvind Kumar Chaurasiya[2]
[1]Research Scholar, [2]Assistant Professor
[1, 2] Department of Horticulture, NEHU, Tura Campus, Meghalaya 794002, India
Email : flory.rapu21@gmail.com
*Corresponding author

INTRODUCTION

Fermentation is a viable technique in preservation as well as development of new products with modified physico-chemical and sensory qualities especially flavor and nutritional components. *Saccharomyces* spp. are the most generally used microorganism for production of fermented beverages as they are comparatively efficient in alcohol production and can withstand higher levels of ethanol than other fungi. They also produce compounds that are believed to influence the final flavor of the fermented liquid (Reed and Nogodawahames 1991). The technology of manufacturing fermented beverages from grape is quite advanced because of the natural chemical balance of the grape juice that aids to fermentation process without the addition of sugars, acids, enzymes, or other nutrients. However, various fruits such as banana, cucumber, pineapple, star fruit and mango can be also used. The usage of different fruits may lead to productions of beverages with different flavors (Obaedo and Ikenebomeh 2009, Chilaka *et al.* 2010, Adiyaman *et al.* 2019, Patel *et al.* 2021).

Aonla fruits is highly nutritious and one of the richest sources of vitamin-C, amino acids and minerals. It contains several chemical constituents like tannins, alkaloids, polyphenols, vitamins and minerals (Dasaroju and Gottumukkala 2014). All these useful natural components, can be extracted during fermentation in the form of fermented beverages with the help of *Saccharomyces cerevisiae*. Blood fruit is one among the lesser known and underutilized fruit plant which has a rich source of antioxidant and pos-

sesses immense nutritive and medicinal value. The high nutritional value of blood fruit indicates good potential for exploration and value-added products like fermented beverages for consumption during off season (Flory *et al*. 2021).

Even though blood fruit and aonla possesses immense nutritive and medicinal value they are less preferred for direct consumption due to less pulp, thick peel and large seed in blood fruit and high astringency taste in aonla fruit. Therefore, these fruits can be prepared into value added products like fermented beverages. Lack of readily available publication on preparation and storage studies of fermented beverages from blood fruit and aonla with respect to sugar types. Therefore, efforts were made to evaluate the response of different source of sugar (palm and cane jaggery) on production of blood fruit and aonla fermented beverages and study on its chemical composition, sensory evaluation and nutrient retention percentage during its storage.

MATERIALS AND METHODS

Sources of materials

Ripe fruits with good appearance, free from diseases were selected. They were purchased from local market in Tura, Meghalaya and bought to the laboratory (Department of Horticulture, North Eastern Hill University) for preparation of fermented beverages

Yeast culture

Commercial yeast Lalvin K1-V1116 *Saccharomyces cerevisiae* INRA- Montpellier was use for fermentation. The yeast was rehydrated with a small portion of must and incubated at room temperature for 48 hours and thereafter added to the total must volume (10 ml/1liter).

Preparation of must for blood fruit and aonla fermented beverages

After washing the fruits, blood fruit were used as whole fruit by giving four scissor cuts and used in the ratio of 1:1 (blood fruit : water) while aonla fruits were first blanched and blitzed in a pulper until a pulp consistency was achieved and used in the ratio of 1:2 (aonla pulp : water). The sugar concentrations were adjusted to 20 ^{o}Brix TSS with palm and cane jaggery, pH adjusted to 3.5 with citric acid and the must were mixed in the combination of Blood fruit+ aonla (70%+30%) for the presence studies to prepared fermented beverages). All fermentations were conducted at room temperature, without agitation in bamboo container and covered with plastic film, each fermentation lasted 9 days. After fermentation they were filtered and stored in amber color bottles and kept for maturation (6 months). Reading were taken at every two months interval till 14 months.

Nutritive analysis

The quality parameters were analyzed by standard methods like TSS (^{o}Brix) by Hand Refractometer, sugars (%) by Lane and Eynon (1923), titratable acidity (%) by AOAC (1990), ascorbic acid (mg/ 100 ml), β-carotene (IU), the total monomeric anthocyanin (mg/100 ml) as describe by Ranganna (2000). Alcohol (%) by automatic digital Alcoholometer Alex 500.

Statistical analysis

The data was tabulated and subjected to analysis of variance (ANOVA) according to factorial completely randomized design. The Critical Difference Value at1% level was used for making comparisons among different treatments by Gomez and Gomez (1984).

Sensory evaluation

The sensory evaluation was carried out to determine the overall acceptability on a 5-point hedonic scale by a panel of 15 judges (adult male and female). The end of storage life of the processed products was determined mostly on the basis of sensory quality and nutritive values (sensory rating 3 and above).

Estimation of benefit : Cost ratio

The benefit **:** Cost ratio was calculated after estimation the cost involved including the operational as well as 10% overhead charges incurred during fermentation of blended fermented beverages.

Table 1. Changes in TSS (°Brix) and total sugar (%) of blood fruit and aonla fermented beverages during storage period. (1) MAS : Month after storage (2) M : Months (3) S : Sugar types (4) M × S : Months × Sugar.

Months	TSS (°Brix)						Total sugar (%)					
	Palm jaggery			Cane jaggery			Palm jaggery			Cane jaggery		
	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
0Month	7.42	7.33	7.38	6.92	7.20	7.06	2.03	2.11	2.07	1.98	2.09	2.04
6MAS	7.40	7.20	7.30	6.67	7.07	6.87	1.66	1.85	1.76	1.59	1.68	1.63
8MAS	7.40	6.73	7.07	6.53	6.47	6.50	1.61	1.70	1.65	1.55	1.65	1.60
10MAS	7.47	6.27	6.87	6.53	5.40	5.97	1.48	1.48	1.48	1.40	1.48	1.44
12MAS	7.40	6.20	6.80	6.13	5.40	5.77	1.45	1.45	1.45	1.39	1.45	1.42
14MAS	7.27	6.13	6.70	5.93	5.47	5.70	1.35	1.38	1.37	1.30	1.37	1.34
Mean			7.02			6.31			1.63			1.58
		SED±	CD (0.01%)			CV %		SED±	CD (0.01%)			CV %
M		0.22	0.61			5.71		0.03	0.07			2.74
S		0.13	0.35					0.01	0.04			
M×S			NS						NS			

Changes in TSS (°Brix)

Table 1 summarizes the changes in the data of pooled mean of two years TSS (°Brix) content of blood fruit and aonla fermented during storage. The TSS content of the fermented beverages was observed to decreased during storage period for both using (palm and cane jaggery) sugar source up to 14 months, the rate of decreasing being more in fermented beverages using cane jaggery followed by palm jaggery, it may be due to utilization of jaggery as a carbohydrate source for growth and development of yeast during fermentation.The total soluble solid content varied from 7.38 to 6.70 °Brix and 7.06 to 5.70 °Brix in fermented beverages using palm and cane jaggery during storage period up to 14 months indicating a non significant effect between storage period and sugar types. Reduction in TSS content during storage was also reported by Joshi *et al.* (2012) in jamun (*Syzygium cuminii* L. Skeels) wine.

Changes in total sugar

Perusal of data in Table 1 pertaining to total sugar content of blood fruit and aonla fermented beverages by using different sugar source observed that the total sugar content of fermented beverages gradually reduces with increasing the duration of storage (14

Table 2. Changes in titratable acidity (%) and ascorbic acid (mg/100 ml) of blood fruit and aonla fermented beverages during storage period. (1) MAS : Month after storage (2) M : Months (3) S : Sugar types (4) M × S : Months × Sugar.

Months	Titratable acidity (%)						Ascorbic acid (mg/100ml)					
	Palm jaggery			Cane jaggery			Palm jaggery			Cane jaggery		
	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
0Month	0.40	0.45	0.42	0.38	0.38	0.38	9.88	9.40	9.64	7.18	7.36	7.27
6MAS	0.43	0.45	0.44	0.40	0.45	0.42	7.11	7.20	7.15	7.04	7.15	7.10
8MAS	0.44	0.47	0.46	0.40	0.46	0.43	4.91	4.76	4.83	3.27	3.91	3.59
10MAS	0.46	0.50	0.48	0.43	0.48	0.45	4.00	3.63	3.82	3.55	3.81	3.68
12MAS	0.49	0.53	0.51	0.50	0.51	0.51	3.29	3.41	3.35	2.52	2.89	2.71
14MAS	0.51	0.54	0.52	0.50	0.51	0.51	3.18	3.07	3.13	2.52	2.55	2.54
Mean			0.47			0.45			5.32			4.48
		SED±	CD(0.01%)			CV %		SED±	CD (0.01%)			CV %
M		0.01	0.03			4.12		0.09	0.24			3.08
S		0.01	0.02					0.05	0.14			
M×S			NS						NS			

Table 3. Changes in anthocyanin (mg/100 ml) and β- carotene (IU) of blood fruit and aonla fermented beverages during storage period.

Months	Anthocyanin(mg/100ml)						β- carotene(IU)					
	Palm jaggery			Cane jaggery			Palm jaggery			Cane jaggery		
	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
0Month	8.77	5.28	7.02	9.06	8.82	8.94	102.98	91.05	97.01	140.33	121.25	130.79
6MAS	4.21	4.60	4.40	5.75	4.28	5.02	92.75	80.82	86.79	92.75	85.94	89.34
8MAS	3.67	4.43	4.05	3.67	4.10	3.88	72.30	72.30	72.30	73.24	78.28	75.76
10MAS	3.51	4.13	3.82	3.56	3.77	3.67	64.30	68.89	66.60	73.20	78.28	75.74
12MAS	3.43	3.24	3.34	3.51	3.37	3.44	58.66	63.35	61.01	70.60	73.23	71.91
14MAS	3.19	3.11	3.15	3.41	3.22	3.32	58.66	62.02	60.34	68.89	73.20	71.04
Mean			4.30			4.71			74.01			85.76
	SED±		CD (0.01%)			CV %	SED±		CD (0.01%)			CV %
M	0.33		0.93			12.75	2.40		6.70			5.19
S	0.19		0.54				1.38		3.87			
M×S	0.47		1.31				3.39		9.47			

months). The rate of decrease was more in fermented beverages prepared using cane jaggery (2.04 to 1.34%) as compared to fermented beverages prepared using palm jaggery (2.07 to 1.37%) up to 14 months of storage. During storage, a steady reduction in total sugar content might be due to slow mobility of sugar molecules within the wine and helped them being utilized in Maillard reaction and other degradative reaction such as formation of organic acid. The values obtained for total sugar showed much more synchronization with the results of an earlier study conducted by Reddy *et al.* (2017) in aonla fermented beverages.

Changes in titratable acidity (%)

It is apparent from the Table 2 that the titratable acid content of fermented beverages increased slightly with increase in the storage duration. It was evident from the result that the titratable acidity content of blood fruit and aonla fermented beverages showed an increasing trend. This might be due to rapid break down of ascorbic acid and pectinous substances (Desrosier and Desrosier1998). The increased in titratable acidity in fermented beverages using palm jaggery (0.42 to 0.52%) as sugar source were more as compared to fermented beverages prepared using cane jaggery(0.38 to 0.51%) . Increase in titratable acidity during storage are in conformity with the findings of Karan *et al.* 2017 in pomegranate based Fermented Nutraceutical Product, Oba *et al.* 2018 in mixed fruit wine produced from physically damaged fruits.

Changes in ascorbic acid

It was observed that the blood fruit and aonla fermented beverages prepared using palm and cane jaggery as carbohydrates sources showed gradual decrease in ascorbic acid content as storage duration increase. It was found that the initial value of ascorbic acid of the freshly prepared fermented beverages using palm jaggery was 9.64 mg/100 ml while it reduces to 2.52 mg/100ml respectively after 14 months of storage. The ascorbic acid was oxidized during storage and the rate of oxidation was more in fermented beverages prepared using cane jaggery. Retention of ascorbic acid (34.94%) was more in cane jaggery as compared to palm jaggery sugar types (32.47%). This findings were in comfirmation with the findings of Adiyaman *et al.* (2019), Suresh *et al.* (2015) in *Emblica officinalis* wine.

Changes in anthocyanin (mg/100 ml)

The anthocyanin content of blood fruit and aonla fermented beverages showed a decreasing trend with increase in storage duration in Table 3 (from 7.02 to 3.15 mg/100ml and 8.94 to 3.32 mg/100 ml) by using palm and cane jaggery as sugar sources respectively loss of anthocyanins during storage is due to degradation and polymerization of anthocyanins with time. The data showed significant interaction effect between storage period and sugar types. The fermented beverages prepared using palm jaggery

Table 4. Changes in Alcohol (%) and Organoleptic taste of blood fruit and aonla fermented beverages during storage period.

Months	Alcohol (%)						Organoleptic taste (5 Hedodic scale)					
	Palm jaggery			Cane jaggery			Palm jaggery			Cane jaggery		
	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
0Month	8.93	9.07	9.00	8.70	8.47	8.59	3.86	3.52	3.69	3.83	3.24	3.54
6MAS	9.57	9.89	9.73	9.41	9.57	9.49	4.20	3.60	3.90	3.50	3.45	3.59
8MAS	9.33	9.48	9.41	8.89	9.10	8.99	4.23	3.91	4.07	4.18	3.78	3.98
10MAS	8.89	9.00	8.95	8.34	8.86	8.60	4.35	3.96	4.15	4.23	3.79	4.01
12MAS	8.80	8.60	8.70	8.33	8.46	8.40	4.37	4.01	4.19	4.26	3.85	4.05
14MAS	8.57	8.51	8.54	8.32	8.24	8.28	4.45	4.18	4.32	4.35	3.97	4.16
Mean			9.05			8.72			4.05			3.89
	SED±		CD (0.01%)			CV %		SED±		CD (0.01%)		CV %
M	0.065		0.183			1.27		0.11		0.31		4.84
S	0.038		0.106					0.06		0.18		
M×S		NS							NS			

have maximum anthocynin retention (44.87 %) as compared to cane jaggery (37%), this might be due to presence of higher alcohol percentage which help in preserving anthocyanin content in the fermented beverages. Similar trend of decrease in anthocyanin with increased in storage duration was reported by Mousavi *et al.* (2011) in probiotic pomegranate juice.

Changes in β-carotene (IU)

The β-carotene content of blood fruit and aonla fermented beverages showed a decreasing trend with increase in storage duration in Table 3 (from 97.01 to 60.34 IU and 130.79 to 71.04 IU by using palm and cane jaggery as sugar sources respectively). As β-carotene are light sensitive so they decreases as storage time increases. The data showed significant interaction effect between storage months and sugar types. At the end of aging maximum retention (62.21%) of β-carotene was observed in fermented beverages prepared using palm jaggery. Similar trend was reported by Adiyaman *et al.* (2019) in star fruit (*Averrhoa carambola* L.) wine.

Alcohol content (%)

At the initial stage, the alcohol content of both fermented beverages ranged between 9% and 8.59% respectively. Due to the impact and unequal distribution of carbohydrate sources from palm and cane jaggery for the growth and development of yeast during fermentation major discrepancy in alcohol content was observed. There was gradual increased in alcohol % in both the fermented beverages after 6 months of storage due to complete conversion of sugar to alcohol. But after 8 months of storage the alcohol content reduces in both the fermented beverages (9 % to 8.54% in palm jaggery and 8.59% to 8.28 % in cane jaggery), this might due to evaporation of alcohol due to inproper packaging. These results, coupled with earlier studies conducted by Reddy *et al.* (2017) in amla fermented beverages Holegar *et al.* (2015) in jamun wine.

Organoleptic characteristics

Acceptability of fermented beverages by the consumers depends on its sensory attributes. The sensory characteristics of the fermented beverages were evaluated by a panel of 15 semi-trained judges based on 5 points hedonic scale up to 14 months of storage and the values are expressed in Table 4. Both the fermented beverages were accepted by the panelist. The organoleptic score increases as the storage duration increases for both the fermented beverages prepared using palm jaggery (3.69 to 4.32) and cane jaggery (3.54 to 4.16). More economical b/c ratio of 3.53 was obtained in fermented beverages using cane jaggery whereas B/C ratio of fermented beverages using palm jaggery (3.32) as sugar source were also beneficial for the producer.

CONCLUSION

It can be concluded from the present study that both palm and cane jaggery are effective carbohydrate (energy) sources for the growth and development of yeast during the fermented beverages processing with better retention of nutrient and sensory parameters. Both the fermented beverages contained significant amount of antioxidant like anthocyanin, ascorbic acid and β-carotene. Therefore,on the basis of the present study, palm jaggery is recommended as a carbohydrate source having higher alcohol% and higher organoleptic score, better anthocyanin and β-carotene retention percentage after 14 months of storage. It is however recommended that further studies should be carried out on different formulation of fermented beverages from blood fruit and aonla by using more different types of sugar as carbohydrate source like fructose, sucrose for growth and development of yeast to see if acceptable fermented beverages would be produced. Other health promoting attributes from the fermented beverages can also be identified for further studies. The fermented beverage of this combination (70% blood fruit+30% aonla) using palm and cane jaggery showed acceptable scores by the panellist so can recommend this beverage for the commercial production and generate the employment based on the B/C ratio.

ACKNOWLEDGMENT

The authors wish to thank the Department of Horticulture, North Eastern Hill University, Tura Campus for providing facilities for conducting the experiment.

REFERENCES

Adiyaman P, Kanchana S, Hemalatha G, Gopal NO (2019) Influence of aging on nutrient retention and organoleptic characteristics of wine developed from star fruit (*Averrhoa carambola* L.). *Emer Life Sci Res* 5 (2) : 17—27.

AOAC (1990) Official methods of analysis. 15th edn Association of Official Analytical Chemists, Washington, DC.

Chilaka CA, Uchechukwu N, Obidiegwu JE, Akpor OB (2010) Evaluation of the efficiency of yeast isolates from palm wine in diverse fruit wine production. *Afr J Food Sci* 4 (12) : 764—774.

Dasaroju S, Gottumukkala KM (2014) Current trends in the research of *Emblica officinalis* (Amla) : A pharmacological perspective. *Int J Pharm Sci Rev Res* 24 (2) : 150—159.

Desrosier Norman W, Desrosier James N (1998) The technology of food preservation. In : Principal of Food Concentrates. 4th edn. CBS Publisher and Distributers, Shahdara, Delhi, (India). pp 259— 277.

Flory RH, Arvind KC, Elavena W, Todik JS (2021) Study on physico-chemical and nutritional properties of blood fruit hematocarpus validus (miers.) bakh. F. ex forman. *Crop Res* 56 (1, 2): 14—19.

Gomez AK, Gomez AA (1984) Statistical procedure for agricultural research. 2nd edn. Wiley, Singapore.

Holegar HR, Suresha GJ, Jagadeesh SL, Kalagudi VK (2015) Influence of thermovinification on quality of Jamun (*Syzygium cumini*) Wine. *Int J Food Ferment Technol* 5 (2) : 259—263.

Joshi VK, Sharma R, Girdher A, Abrol GS (2012) Effect of dilution and maturation on physico-chemical and sensory quality of jamun (*Black plum*) wine. *Ind J Nat Prod Res* 3 (2) : 222—227.

Karan M, Sreenivas KN, Reddy MC, Manjula GS, Ulla HMT (2017) Pomegranate (*Punica granatum* L.) based fermented nutraceutical product. *Int J Curr Microbiol Appl Sci* 6 (12) : 2054—2063.

Lane JH, Eynon L (1923) Determination of reducing sugar by Fehling's solution with methylene blue as indicator. *J Soc Chem Indica* 42:32.

Mousavi ZE, Mousavi SM, Razavi SH, Emmam-Djomeh Z. Kiani H (2011) Effect of fermentation on pomegranate juice by *Lactobacillus planatarum* and *Lactobacillus acidophilus* on the anti-oxidants activity and metabolism of sugars, organic acids, and phenolic compounds. *World J Microbiol Biotech* 27 (2) : 123—128.

Oba DO, Okunola OJ, Oranusi SU, Okagbue HI (2018) Data on microbial and physico-chemical assessment of mixed fruit wine produced from physically damaged fruits. *Data in brief* (*Elsevier*) 19 : 678—86.

Obaedo ME, Ikenebomeh MJ (2009) Microbiology and production of banana (*Musa sapientum*) wine. *Niger J Microb* 23 (1) : 1886—1891.

Patel V, Tripathi AD, Adhikari KS, Srivastava A (2021) Screening of physicochemical and functional attributes of fermented beverage (wine) produced from local mango (*Mangifera indica*) varieties of Uttar Pradesh using novel *saccharomyces* strain. *J Food Sci Technol* 58(6) :2206—2215.

Ranganna S (2000) Handbook of analysis and quality control for fruit and vegetable products. 2nd edn. Tata and Mc Graw – Hill Publishing Co Ltd, New Delhi.

Reddy MC, Sreenivas KN, Manjula GS, Karan M, Ulla HMT (2017) Aonla (*Emblica officinalis* Gaertn.) based fermented beverages. *Int J Cur Microb Appl Sci* 6 6 (10) : 4740—4749.

Reed G, Nogodawahames TW (1991) Yeast technology. *J Sci* 2 : 310—320.

Suresh HL, Sreenivas KN, Thotad M, Ramakrishna BM, Shankarappa TH, Krishna HC (2015) Fermentation extraction of aonla components into wine at varied levels of sugar concentrations. *Environ Ecol* 33 (1A) : 203—207.