Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(4): 28-31
Received: 18-05-2018
Accepted: 22-06-2018

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Effect of different sources of sugars and TSS levels on quality of sapota [*Manilkara achras* (Mill) foresberg] wine Cv. kalipatti

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Abstract

An investigation was undertaken at Fruit Beverages Research Centre, Department of Soil Science and Agricultural Chemistry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli to study the effect of different sources of sugars and TSS levels on quality of sapota wine. The experiment was planned using four sources of sugars (Sucrose, Fructose, Dextrose, Jaggary) and four TSS levels (25, 30, 35 and 40 ^{0}Brix) using factorial completely randomized design (FCRD).The sapota juice contained TSS 23.9 ^{0}Brix, pH 5.10, titratable acidity 0.16 per cent, 6.88 mg 100 g^{-1} ascorbic acid, 8.27 per cent reducing sugars, 17.60 per cent total sugars, 1.91 per cent aldehyde and SO_2 contained 49.9 ppm, 0.77 per cent proteins and 0.26 per cent tannins respectively.

The wine prepared from sapota juice having TSS 25 ^{0}Brix with sucrose sugar at pH 3.5 recorded highest alcohol content (14.48 %), desirable level of TSS (8.40 ^{0}Brix) and tannin content (0.241%). The organoleptic evaluation of wine revealed that the wine prepared from the treatments T_1S_1, T_1S_2, T_1S_3, T_2S_1 and T_2S_3 were found to be superior over other remaining treatments.

The maximum wine recovery was obtained in the treatment T_1S_1 (62.80%) followed by the treatment T_2S_1 (60.65%) in which the wine was prepared by using sucrose sugar at 25 ºB and 30 ºB respectively. The cost of production for 1 kg wine was lower (96.40 Rs) in the treatment T_1S_1 i.e. wine prepared by using sucrose sugar at 25 ^{0}B TSS levels.

From the present investigation, considering both the chemical composition and organoleptic evaluation of wine prepared from different sources of sugars and TSS levels, it can be concluded that 25 ^{0}Brix TSS level by using sucrose sugar at 3.5 pH were the optimum conditions for preparation of good quality wine from sapota juice.

Keywords: sapota, wine, sugar, TSS, yeast

Introduction

Sapota (*Manilkara achras* (Mill) Forsberg) is one of the prominent fruits and belongs to family *Sapotaceae*. In India Maharashtra and Gujarat together account for the largest area under this crop out of total area of 69.1 thousand ha. and production 298.0 MT under sapota in Maharashtra with productivity of 4.3 MT/ ha. (Indian horticulture database 2010: Area & Production Report). There are about three dozen varieties of sapota grown in different parts of the country (Irulappan, 1991) [7]. Of these 'Kalipatti' is the leading variety of Maharashtra, Gujarat and North Karnataka states (Chundawat and Bhuva, 1982). The sapota fruits are a good source of sugar which ranges between 12 to 14 per cent. A 100 g of edible portion of fruit contains moisture (73.7 g), carbohydrates (21.49 g), protein (0.7 g), fat (1.1 g), calcium (28 mg), phosphorus (27 mg), Iron (2 mg) and ascorbic acid (6 mg) as reported by Bose and Mitra (1990) [3]. The plantations of sapota in some part of Gujarat and Thane district of Maharashtra are facing the problem of seed borer attack. Even though the borer attacks only the seed, the hole made in the fruit affects the appearance of the fruit and such fruits (15 to 20%) are rejected in the markets. Such fruits can also be used for wine preparation. Even glut in the market affects the rate considerably. Since sapota fruit contains high sugars (12-18%), with high flesh to seed ratio (80.9), it is the best raw material for wine industry. The processing industry can also be run throughout the year, as the fruits are available in all seasons. The technology of manufacturing wine from grape is quite advanced. However, limited information is available on the preparation of wines from other fruits, especially sapota with respect to different TSS levels with different sources of sugars. It was therefore thought to utilize sapota fruits for wine making. The sapota wine industry will help to generate rural employment and also will give higher returns to the farmers particularly during the seasonal glut. Keeping in view of the above facts and in order to produce good quality wine from sapota in a hygienic way.

Materials and Methods

The present investigation on "Effect of different sources of sugars and TSS levels on quality of Sapota [*Manilkara achras* (Mill) Forseberg] wine Cv. Kalipatti**"** was conducted at Fruit Beverages Research Centre, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during the year 2010-2011. Sapota juice was diluted with distilled water in 1:1(w/w) proportion. The juice so obtained was used for preparation of must and wine. For preparation of yeast culture, initially total *must* was dispensed in fermentation flask as per the treatment & then quantity of yeast powder required for inoculation of each treatment was calculated @ 0.3g/kg of *must.* Yeast powder was then added to sterilized test tube containing 10 times luke warm water under aseptic conditions in laminar air flow bench. These test tubes were kept for 1 hour at room temperature for activation of yeast. After 1 hour, prepared inoculums was added to must in fermentation flask and allowed to ferment. The 1 kg clear diluted juice was taken in different vessels and the TSS content of juice was adjusted to 25º, 30º, 35º and 40º Brix by addition of sucrose, fructose, dextrose, Jaggery separately. The pH was adjusted to 3.5 by addition of citric acid and calcium carbonate. The juice was supplemented with 0.1% diammonium hydrogen phosphate (DAHP) and potassium metabisulphate (KMS) equivalent to 30 ppm SO_2. After adjusting the T.S.S, pH and addition of DAHP and KMS, the juice i.e. must was taken in fermentation flask and pasteurized at 80º C for 20 minutes and then used further for fermentation followed by inoculation of yeast culture.

Results and Discussion

TSS, pH, titratable acidity, ascorbic acid, reducing sugar and total sugar content of sapota juice was 23.9 ^{0}Brix, 5.10, 0.16 per cent, 6.88 mg100 ml^{-1}, 8.27 per cent and 17.60 per cent respectively. The juice recorded aldehyde 1.914 per cent, SO_2 49.9 ppm, 0.77 per cent protein and 0.26 per cent tannins content.

The effect of different sources of sugars and TSS levels on TSS and pH content of sapota wine is presented in Table 1. Considering the TSS levels, lowest TSS (8.77 ^{0}B) was observed in the treatment T_1 i.e. 25 ^{0}B TSS level. The treatment T_1 was significantly superior over rest of all other treatments while the treatment T_4 recorded highest TSS (27.41 ^{0}B), irrespective of sources of sugars. The treatment S_2 i.e. TSS levels adjusted by fructose showed lowest (3.52) pH, which found significantly superior over rest of the treatments. While the highest pH (3.79) was observed in the wine prepared by using Jaggery i.e. S_4 treatment.

The titratable acidity ranged in between 0.52 per cent to 0.77 per cent (Table 2). The lowest acidity (0.52%) was recorded in the wine prepared by using sucrose sugar i.e. S_1 and it was significantly superior over rest of the treatments. The wine prepared by 25^{0}B and 30^{0}B TSS levels recorded the lowest acidity (0.58%) which was found significantly superior on T_3 and T_4 treatments i.e. 35ºB and 40^{0}B TSS levels treatments. However Anand (2003) [2] reported an increase in acidity with increase in TSS levels in cashew apple wine. The range of acidity (o.52-0.77%) obtained in present study for sapota wine agreed with values reported by Gautam and Chundawat (1998) [5] who reported lower values for titratable acidity (0.59-1.21%), Sonar (2002) [12] for jamun wine (0.81-1.92%) and Anand for Cashew apple wine (0.37-0.69%). The highest ascorbic acid content (6.79 mg 100ml^{-1}) was observed in treatment S_4 in which Jaggery was used for preparation of wine (Table 2). While the lowest ascorbic acid content (2.99 mg 100ml^{-1}) was observed in the treatment S_3 i.e. wine preparation with dextrose sugar. Treatment S_4 was significantly superior over S_1, S_2 and S_3 treatments.

Table 1: Effect of different sources of sugars and TSS levels on TSS and pH content of sapota wine

TSS level	TSS (^{0}B)					pH				
	Source of sugars					Source of sugars				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	8.40	8.63	8.83	9.20	8.77	3.79	3.57	3.83	3.83	3.76
T_2	15.40	15.37	17.57	14.00	15.58	3.56	3.47	3.59	3.89	3.63
T_3	22.00	20.83	20.27	17.87	20.24	3.64	3.50	3.62	3.70	3.62
T_4	27.23	28.33	28.40	25.67	27.41	3.52	3.54	3.56	3.72	3.59
Mean	18.26	18.29	18.77	16.68	18.00	3.63	3.52	3.65	3.79	3.65

	TSS (^{0}B)			pH		
	T	S	T x S	T	S	T x S
S. Em ±	0.17	0.17	0.66	0.01	0.01	0.04
C.D (P=0.01)	0.64	NS	NS	0.04	0.04	NS

Table 2: Effect of different sources of sugars and TSS levels on titratable acidity and ascorbic acid content of sapota wine

TSS level	Titratable acidity (%)					Ascorbic acid (mg 100ml^{-1})				
	Source of sugars					Source of sugars				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	0.53	0.61	0.55	0.63	0.58	2.40	3.75	2.76	3.64	3.14
T_2	0.52	0.64	0.47	0.69	0.58	3.71	2.03	3.46	5.95	3.79
T_3	0.48	0.58	0.62	0.83	0.63	3.22	3.29	3.25	5.11	3.72
T_4	0.55	0.53	0.52	0.94	0.64	2.97	3.25	2.49	12.46	5.29
Mean	0.52	0.59	0.54	0.77	0.61	3.08	3.08	2.99	6.79	3.98

	Titratable acidity (%)			Ascorbic acid (mg 100ml^{-1})		
	T	S	T x S	T	S	T x S
S. Em ±	0.00	0.00	0.01	0.03	0.03	0.13
C.D (P=0.01)	0.01	0.01	0.05	0.13	0.13	0.51

The highest reducing sugars (4.89 per cent) recorded in the wine prepared from sucrose i.e. S_1 treatment which was significantly superior over all other sugar treatments (Table 3). The highest reducing sugar content (8.65%) was recorded by T_4 i.e. 40 ^{0}B which was significantly superior over rest of the treatments. The lowest total sugars (traces) was observed by T_1 i.e. 25 ^{0}Btreatment. This might be due to complete exhaustion of sugars at the end of fermentation period as indicated by its low TSS content in the wine. This increase in reducing sugar content was the impact of TSS levels adjusted in *must* by addition of sugar. Sugar content values from traces to 0.4 per cent have been reported by Shukla *et al*. (1991) and Jagtap (2010) for jamun wine. The trace reducing sugar content was recorded by the treatment combinations T_1S_1, T_1S_2, T_1S_3 and T_1S_4. Sugars are indispensible for the production of practically all types of wines. The observation of Amerine *et.al.* (1980) [1] that sucrose was rapidly hydrolyzed during fermentation and was present in very small amounts in grape wine also agreed well with present findings. The highest total sugar content (5.50%) was recorded in the wine prepared by using fructose sugar i.e. S_2 treatment which was statistically at par with S_1 and S_3 treatments (Table 3). The highest total sugars (9.20%) content was recorded by T_4 at 40 ^{0}B TSS levels which was found significantly superior over rest of the treatment and the lowest was observed in T_1 treatment (Trace). Increasing trend with increase in TSS levels irrespective of sources of sugars, same as that of reducing of sugars, due to addition of sugars to maintain different TSS levels in *must.* Similar results were obtained by Aananda (2003) [2].

Table 3: Effect of different sources of sugars and TSS levels on reducing and total sugars content of sapota wine

TSS level	Reducing sugars (%)					Total sugars (%)				
	Source of sugars					Source of sugars				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	Tr	Tr	Tr	Tr	0.00	Tr	Tr	Tr	Tr	0.00
T_2	3.49	3.19	4.60	3.83	3.78	4.58	4.68	4.76	4.52	4.64
T_3	6.52	5.37	4.80	4.76	5.36	7.36	7.48	6.82	6.59	7.06
T_4	9.54	8.92	9.23	6.93	8.65	9.50	9.83	10.16	7.29	9.20
Mean	4.89	4.37	4.66	3.88	4.45	5.36	5.50	5.44	4.60	5.22

	Reducing sugars (%)			Total sugars (%)		
	T	S	T x S	T	S	T x S
S. Em ±	0.05	0.05	0.19	0.05	0.05	0.18
C.D (P=0.01)	0.19	0.19	0.75	0.18	0.18	0.71

(Tr-Trace)

The lowest SO_2 content (27.10 ppm) was recorded in the wine prepared by sucrose i.e. S_1 (Table 4). This was significantly superior over rest of the treatments irrespective of TSS levels. The treatment S_4 i.e. wine prepared by Jaggery recorded highest SO_2 content i.e. (38.5 ppm). It might be due to addition of Jaggery which contains sulphur and leads to increase the aldehyde content. Aldehyde is strongly bound with SO_2 with important implications for wine production Increasing trend was observed in case of sugars sources. The lowest SO_2 content (29.85 ppm) recorded by T_1 i.e. 25^{0}B TSS level, which was statistically at par with treatment T_2 i.e. 30^{0}B TSS level. Highest SO_2 content (32.19 ppm) was recorded by the treatment T_4 at 40^{0}B TSS levels. Increasing trend was observed with increasing the TSS levels. Similar findings were reported by Gautam and Chudawat (1998) [5] in sapota wine. Highest alcohol content (13.93%) was recorded in the wine prepared by sucrose sugar which was significantly superior over the rest of the treatments and lowest (10.55%) in the wine prepared by Jaggery (Table 4). In the different TSS levels, the highest alcohol content (12.96%) of wine recorded by T_4 at 40^{0}B which was significantly superior over the rest of the treatments and lowest (11.50%) recorded by T_3 i.e. 35^{0}B. Sugars are the main constituent of TSS which is converted to alcohol by the action of yeast. Yeast produces pyruvic decarboxylase and alcoholdehydrogenase enzymes and converts reducing sugars to ethyl alcohol. The decrease in alcohol content was observed with increase in TSS levels, except T_4.

Table 4: Effect of different sources of sugars and TSS levels on SO_2 and alcohol content of sapota wine

TSS level	SO_2 (ppm)					Alcohol (%)				
	Source of sugars					Source of sugars				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1	25.20	28.20	29.80	36.20	29.85	14.48	12.58	12.18	11.26	12.62
T_2	26.20	28.60	31.10	36.00	30.48	13.16	12.08	11.32	10.52	11.77
T_3	27.60	30.90	34.20	38.90	32.89	13.68	12.99	11.09	8.23	11.50
T_4	29.40	34.10	35.80	42.80	35.53	14.38	12.50	12.74	12.21	12.96
Mean	27.10	30.50	32.72	38.50	32.19	13.93	12.54	11.83	10.55	12.21

	SO_2 (ppm)			Alcohol (%)		
	T	S	T x S	T	S	T x S
S. Em ±	0.27	0.27	1.08	0.05	0.05	0.22
C.D (P=0.01)	1.05	1.05	NS	0.21	0.21	0.85

Decrease in alcohol content with increasing TSS level may be the effect of high concentration of sugars at T_2 and T_3 which affects yeast activity and ultimately the conversion of sugars to alcohol [Adsule *et.al.* (1995) and Honde *et.al.* (1998)] [6]. In case of interaction effect of TSS levels and sugars sources, the interaction T_1S_1 recorded higher (14.48%) alcohol content and which was statistically at par with T_3S_2 and T_4S_2.

Table 5: Effect of different sources of sugars and TSS levels on final wine recovery (on *must* basis) and its cost of production

Treatments	Sources of sugars	Rate of sugar	Quantity of sugar used/ kg juice	Total cost of sugar (Rs.)	Wine recovery (%) on *must* basis	Cost of production/ kg wine (Rs.)
T_1S_1	Sucrose	Rs.16/500g	177 g	5.66	62.80	96.40
T_1S_2	Fructose	Rs.660/500g	188 g	248.16	43.72	363.16
T_1S_3	Dextrose	Rs.145/500g	195 g	56.55	55.17	152.44
T_2S_1	Sucrose	Rs.16/500g	265 g	8.48	60.65	99.57
T_2S_3	Dextrose	Rs.145/500g	270 g	78.30	59.77	142.34

The maximum wine recovery (62.80%) was obtained in the treatment T_1S_1 followed by the treatment T_2S_1 (60.65%) in which the wine was prepared by using sucrose sugar at 25 ºB and 30 ºB respectively (Table 5). The minimum wine recovery (43.72 %) was recorded in T_1S_2 treatment combination i.e. wine prepared by using fructose at 25ºB TSS level. The cost of production per kg of wine observed lower (96.40 Rs.) in the wine prepared by using sucrose sugar at 25^0B TSS levels i.e. T_1S_1 treatment combination, while higher cost of production (363.16 Rs.) was recorded in the wine prepared by using fructose sugar i.e. T1S2 treatment combination.

Conclusion

Considering the chemical composition, wine recovery and cost of production of wines prepared from different sources of sugars and T.S.S. levels, it can be concluded that 25 ^{0}Brix T.S.S. level and sucrose as a source of sugar are the optimum conditions for preparation of good quality sapota wine at 3.5 pH.

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