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Original Research Article

Effect of Different Dilution and pH Levels on Quality of Kokum (*Garcinia indica* Choisy) Wine

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A B S T R A C T

The experiment, was laid out in Factorial completely randomized design with five dilution levels of kokum juice (1:0, 1:0.5. 1:1.0, 1:1.5 and 1:2) and two pH levels (3.5 and 4.0). T.S.S., reducing sugars and total sugars of wine followed decreasing trend with dilution levels except both the sugars increased at higher dilutions (D_4 and D_5). The titratable acidity, anthocyanin and tannins recorded decreasing trend with increase in dilution while pH showed increasing trend. Alcohol content increased from D_1 (7.83 %) to D_4 (10.26%) and thereafter it decreased at D_5 (8.44%) level of dilution. The T.S.S., reducing sugars, total sugars, acidity, anthocyanin and tannins content of wine showed a decreasing trend while pH and alcohol showed increasing trend with increase in pH level. The kokum wine prepared with 1.0:1.5 (juice: water) dilution level and 3.5 pH along with 25^0B T.S.S. was found to be best considering the chemical composition and sensory evaluation of wine.

Keywords

Kokum wine, Dilution levels, pH levels

Introduction

Kokum (*Garcinia indica* Choisy) a tropical fruit, is a native of India can be viewed as a wonder berry that has a pleasant, tangy-sweet taste and a myriad of health benefits. The therapeutic properties of kokum fruits have been described in traditional medicine Ayurveda. Kokum fruit contains hydroxyl citric acid (HCA) is a potential anti-obesity agent, B-complex vitamins, and minerals like potassium, manganese and magnesium, that help in controlling heart rate and blood pressure, offering protection against stroke and coronary heart diseases. This versatile fruit has been used to counter digestive problems such as indigestion, flatulence, acidity and constipation. Kokum fruit possess useful antioxidant, chelating, anti-cancer, anti-fungal, anti-inflammatory, antibacterial, cardio protective and anti-ulcer activities. Life-enhancing antioxidant found in kokum pericarp is called Xanthone. The anthocyanin pigments obtained from it are used as natural colouring agents for food preservation (Anon., 2012).

It is mostly found in Konkan region of Maharashtra, Goa, Karnataka, Kerala and Surat district of Gujarat on the West Coast of India and to some extent in the forests of Assam, Meghalaya, and West Bengal. As per a base line survey in 2010, kokum is grown on about 1000 ha area in the Konkan region

with production of about 4500 MT fruits (Annon., 2012). It is seen from the base line survey 2014, harvesting of kokum fruit coincides in Western Ghat with the monsoon and more than 70 per cent of harvesting trapped in heavy rains and hence lost (Annon., 2014). Majority of yield in kokum used only for syrup and juice preparation during summer months, some parts are dried and stored. Remaining part is not harvested and goes as waste. It can be used to produce fermented beverages like wine. Fruit wines are undistilled alcoholic beverages which are nutritive, more tasty and mild stimulants (Darby, 1979). Being fruit based fermented and undistilled product, wine contains most of the nutrients present in the original fruit juice. The kokum fruits can be used for the manufacture of wine and liquor and could be a good substitute of grapes in the wine industry. The juice of ripe fruit is appearing red colour. It was therefore, thought to utilize kokum fruits for wine preparation. The kokum juice is having dark colour and more acidity, hence in order to reduce colour and acidity of wine and to get good amount of quality wine with light alcohol, the wines were prepared from kokum juice by diluting the juice and adjusting the pH levels of must.

Materials and Methods

The experiment was conducted with five dilution levels of kokum juice D_1 to D_5 (1:0, 1:0.5. 1:1.0, 1:1.5 and 1:2) and two pH levels P_1 and P_2 (3.5 and 4.0) in factorial completely randomized design. For this study, well ripe, sound, healthy and disease free kokum fruits were collected from kokum tree present on educational farm of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, during April 2015. Juice was extracted from fruits (Fig. 1) and must was prepared by diluting the juice as per the treatments by adding distilled water and then T.S.S. of each treatment was adjusted to 25^0Brix by addition of sugar. Then the pH of must was adjusted to two different levels i.e. 3.5 and 4.0 as per the treatments of pH levels by addition of calcium carbonate. The prepared must was inoculated with yeast culture (*Saccharomyces cerevisiae* var. bayanus) and fermentation was allowed to continue till the must showed constant T.S.S. (Fig. 2). The prepared wine was analyzed for chemical composition and sensory characteristics.

Total soluble solids (T.S.S.) were determined with the help of Hand refractometer (Erma Japan, 0 to 32^{o}Brix) and value was corrected at 20°C with the help of temperature correction chart (A.O.A.C., 1975). The pH of the wine was determined with the help of pH meter. (Model Systronics µ pH system 361). The titratable acidity (%), reducing sugars (%), total sugars (%), anthocyanin (mg/100 g) and tannins (%) were estimated as per the methods suggested by Ranganna (1977). The alcohol (%) content in kokum wine was determined by the method as reported by Natu *et al.*, (1986). Sensory evaluation of wine was done by scoring wines numerically on a 20 point score card under six categories of sensory quality characteristics as per the method given by Ough and Baker (1961).

Results and Discussions

The fresh kokum juice used for must preparation was contained T.S.S., reducing sugars, total sugars, titratable acidity, pH, anthocyanin and tannins, 13.45^0B, 5.23 per cent, 7.56 per cent, 4.8 per cent, 2.42, 3380 mg/100g, 1.73 per cent, respectively.

Effect of dilution and pH levels on chemical composition and sensory evaluation of kokum wine is presented in Table 1 to 4. Total soluble solids (Table 1) showed decreasing trend from D_1 to D_4 (9.65 to 8.40^0B) and at D_5 (9.10) it was increased. Decrease in T.S.S. with increase in dilution

level may be due to better fermentation with increase in dilution level, due to dilution of acids and other chemicals which affect the fermentation process. The titratable acidity recorded decreasing trend from 1.03 to 0.68 per cent with increase in dilution level (Table 2). The decrease in acidity with increase in dilution levels may be due to the impact of dilution of juice. The observations are in accordance with the findings of Joshi *et al.*, (1990) in apricot and Taskar (2007) in jamun wine. Reducing sugars and total sugars followed decreasing trend up to dilution level D_3 then after increased at D_4 and D_5 (Table 1). Decrease in reducing sugars with increase in dilution level may be due to more conversion of reducing sugars into alcohol and increase in reducing sugars at D_4 and D_5 may be the effect of more dilution of juice which affected fermentation process. Increase in reducing sugars with increase in dilution was also reported by Sapkal (2011) in ripe mango wine. The pH (3.81 to 4.03) showed increasing trend with increase in dilution level. This increase in pH with increase in dilution level may be due to decrease in acidity of wine due to dissociation of parental acids and formation of hydrogen ions. Increase in pH with decrease in acidity was also reported by Bardiya *et al.*, (1974) in guava and Suresh and Ethiraj (1987) in grape. However anthocyanin (1555 to 540 mg /100 g) and tannins (0.08 to 0.02%) decreased with increase in dilution. Decrease in anthocyanin and tannins with increase in dilution levels may be due to dilution of original anthocyanin and tannin content of kokum juice by dilution with water. Similar results regarding tannins were reported by Sapkal (2011) in mango wine. Alcohol content increased from D_1 (7.83 %) to D_4 (10.26%) and thereafter it decreased at D_5 (8.44%) level of dilution (Table 3). Increase in alcohol with increase in dilution level may be due to the better fermentation with increase in dilution level, due to dilution of acids and other chemicals which affects the fermentation process. However, decrease in alcohol at D_5 may be the effect of more dilution which might have affected fermentation process.

The T.S.S. (9.64 to 8.44^0Brix), reducing sugars (2.64 to 0.91%), total sugars (2.94 to 1.13%), acidity (1.13 to 0.59), anthocyanin (1160 to 1038 mg/100 g) and tannins (0.05 to 0.04) showed a decreasing trend while pH (3.63 to 4.20) and alcohol (8.34 to 10.11 %) showed increasing trend with increase in pH level. Decrease in reducing sugars may be due to better multiplication of yeast at pH 4.0 (P_2) which reflected in better fermentation and conversion of reducing sugars into alcohol. Similar findings were reported by Sonar (2002) in jamun wine. The acidity has an inverse relation to the pH hence as the pH is adjusted in an increasing trend acidity showed a decreasing trend. These observations are in accordance with the findings of Jagtap (2010) in jamun wine. Higher alcohol at pH 4 may be due to better fermentation of must at higher pH level. Sarkale (2012) also found that alcohol content of kokum wine increased with increasing pH Levels.

Among the interactions the lowest T.S.S. and reducing sugars were observed in interaction D_4P_2 (7.60^0B) and D_3P_2 (0.12 %), respectively. Interaction D_3P_2 (0.48 %) recorded lowest total sugar content which was at par with D_4P_2 (0.52%). Lowest pH was recorded by interaction D_1P_1 (3.58), and D_2P_1 (3.58), it was at par with D_3P_1 (3.61). Interaction D_1P_1 (1.34 %) recorded highest titratable acidity which was at par with D_2P_1 (1.28 %). Interaction D_1P_1 recorded the highest anthocyanin content (1610 mg 100 g-1) and lowest tannin content was observed in the treatment combination D_5P_2 (0.01 %). Interaction D_4P_2 (11.32%) recorded higher alcohol.

Table.1 Effect of dilution and pH levels on T.S.S., reducing sugars and total sugars of kokum wine

T.S.S. (^{0}Brix)				Reducing sugars (%)				Total sugars (%)			
Dilution levels	**pH levels**			**Dilution levels**	**pH levels**			**Dilution levels**	**pH levels**		
	P_1	**P_2**	**Mean**		**P_1**	**P_2**	**Mean**		**P_1**	**P_2**	**Mean**
D_1	10.30	9.00	**9.65**	**D_1**	3.33	1.39	**2.36**	**D_1**	3.91	1.61	**2.76**
D_2	9.60	8.70	**9.15**	**D_2**	3.13	1.20	**2.17**	**D_2**	3.33	1.29	**2.31**
D_3	9.50	8.30	**8.90**	**D_3**	0.35	0.12	**0.24**	**D_3**	0.71	0.48	**0.60**
D_4	9.20	7.60	**8.40**	**D_4**	2.38	0.30	**1.34**	**D_4**	2.43	0.52	**1.48**
D_5	9.60	8.60	**9.10**	**D_5**	4.00	1.52	**2.76**	**D_5**	4.33	1.73	**3.03**
Mean	**9.64**	**8.44**	**9.04**	**Mean**	**2.64**	**0.91**	**1.77**	**Mean**	**2.94**	**1.13**	**2.03**
	S.Em ±		**C.D. at 1%**		**S.Em ±**		**C.D. at 1%**		**S.Em ±**		**C.D. at 1%**
Dilution levels (D)	0.061		0.244	**Dilution levels (D)**	0.025		0.102	**Dilution levels (D)**	0.035		0.139
PH levels (P)	0.038		0.154	**PH levels (P)**	0.016		0.064	**PH levels (P)**	0.022		0.088
Interaction (D x P)	0.086		0.345	**Interaction (D x P)**	0.036		0.144	**Interaction (D x P)**	0.049		0.196

D : Dilution levels (Juice : Water) D_1 - 1.0 : 0.0 D_2 - 1.0 : 0.5 D_3 - 1.0 : 1.0 D_4 - 1.0 : 1.5 D_5 - 1.0 : 2.0

P : pH levels P_1 - 3.5 P_2 - 4.0

Table.2 Effect of dilution and pH levels on titratable acidity, pH and anthocyanin of kokum wine

Titratable acidity (%)				pH				Anthocyanin (mg / 100g)			
Dilution levels	**pH levels**			**Dilution levels**	**pH levels**			**Dilution levels**	**pH levels**		
	P_1	**P_2**	**Mean**		**P_1**	**P_2**	**Mean**		**P_1**	**P_2**	**Mean**
D_1	1.34	0.71	**1.03**	**D_1**	3.58	4.04	**3.81**	**D_1**	1610.00	1500.00	**1555.00**
D_2	1.28	0.68	**0.98**	**D_2**	3.58	4.08	**3.83**	**D_2**	1520.00	1410.00	**1465.00**
D_3	1.15	0.58	**0.87**	**D_3**	3.61	4.21	**3.91**	**D_3**	1270.00	1200.00	**1235.00**
D_4	1.00	0.51	**0.76**	**D_4**	3.70	4.30	**4.00**	**D_4**	790.00	610.00	**700.00**
D_5	0.90	0.45	**0.68**	**D_5**	3.70	4.35	**4.03**	**D_5**	610.00	470.00	**540.00**
Mean	**1.13**	**0.59**	**0.86**	**Mean**	**3.63**	**4.20**	**3.92**	**Mean**	**1160.00**	**1038.00**	**1099.00**
	S.Em ±		**C.D. at 1%**		**S.Em ±**		**C.D. at 1%**		**S.Em ±**		**C.D. at 1%**
Dilution levels (D)	0.017		0.068	**Dilution levels (D)**	0.013		0.051	**Dilution levels (D)**	9.487		38.174
pH levels (P)	0.011		0.043	**pH levels (P)**	0.008		0.032	**pH levels (P)**	6.000		24.144
Interaction (D x P)	0.024		0.096	**Interaction (D x P)**	0.018		0.072	**Interaction (D x P)**	13.416		53.987

D : Dilution levels (Juice : Water) D_1 - 1.0 : 0.0 D_2 - 1.0 : 0.5 D_3 - 1.0 : 1.0 D_4 - 1.0 : 1.5 D_5 - 1.0 : 2.0

P : pH levels P_1 - 3.5 P_2 - 4.0

Table.3 Effect of dilution and pH levels on tannins and alcohol of kokum wine

Tannins (%)				Alcohol (%)			
Dilution levels	**pH levels**			**Dilution levels**	**pH levels**		
	P_1	**P_2**	**Mean**		**P_1**	**P_2**	**Mean**
D_1	0.09	0.07	**0.08**	**D_1**	7.45	8.21	**7.83**
D_2	0.06	0.06	**0.06**	**D_2**	8.97	10.00	**9.49**
D_3	0.05	0.04	**0.05**	**D_3**	9.03	11.20	**10.12**
D_4	0.03	0.02	**0.03**	**D_4**	9.20	11.32	**10.26**
D_5	0.02	0.01	**0.02**	**D_5**	7.07	9.80	**8.44**
Mean	**0.05**	**0.04**	**0.05**	**Mean**	**8.34**	**10.11**	**9.23**
	S.Em ±	**C.D. at 1%**			**S.Em ±**	**C.D. at 1%**	
Dilution levels (D)	0.001	0.005		**Dilution levels (D)**	0.153	0.614	
pH levels (P)	0.001	0.003		**pH levels (P)**	0.097	0.388	
Interaction (D x P)	0.002	0.007		**Interaction (D x P)**	0.216	0.869	

D : Dilution levels (Juice : Water) D_1 - 1.0 : 0.0 D_2 - 1.0 : 0.5 D_3 - 1.0 : 1.0 D_4 - 1.0 : 1.5 D_5 - 1.0 : 2.0

P : pH levels P_1 - 3.5 P_2 - 4.0

Table.4 Sensory evaluation of kokum wine

Sr. No.	Treatment	Colour & Appea-rance	Body	Aroma	Taste	Astrin-gency	Overall Accept-ability	Overall quality (Avg score)
1	**D_1P_1**	8	9	7	7	8	7	8
2	**D_1P_2**	8	9	6	6	7	7	7
3	**D_2P_1**	9	10	8	8	9	8	9
4	**D_2P_2**	9	10	7	7	8	8	8
5	**D_3P_1**	10	11	9	9	10	9	10
6	**D_3P_2**	10	12	8	8	9	9	9
7	**D_4P_1**	13	13	12	13	12	13	13
8	**D_4P_2**	12	14	10	9	10	10	11
9	**D_5P_1**	14	11	10	11	13	11	12
10	**D_5P_2**	13	12	9	10	11	12	11
11	**Grape wine (Control)**	16	15	16	15	14	16	15

D : Dilution levels (Juice : Water) D_1 - 1.0 : 0.0 D_2 - 1.0 : 0.5 D_3 - 1.0 : 1.0 D_4 - 1.0 : 1.5 D_5 - 1.0 : 2.0

P : pH levels P_1 - 3.5 P_2 - 4.0

Fig.1 Extraction of juice from kokum fruits

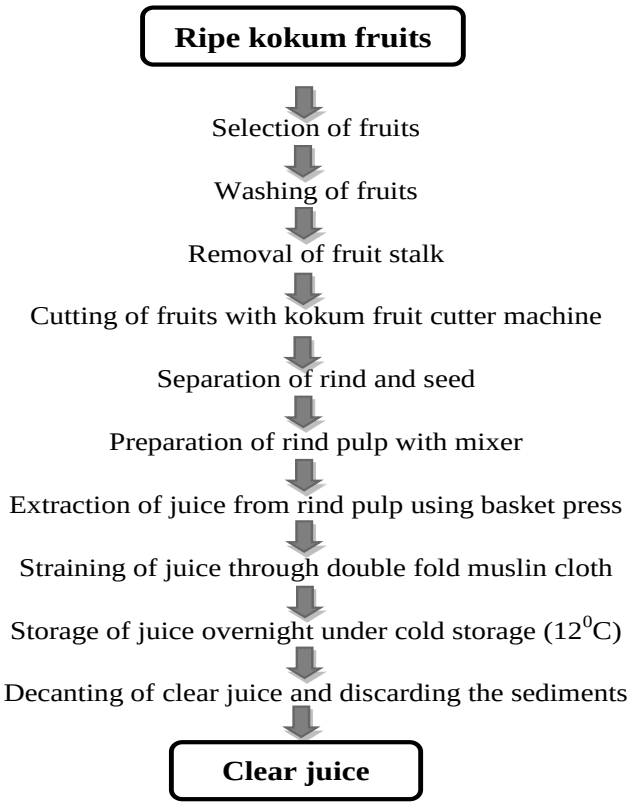
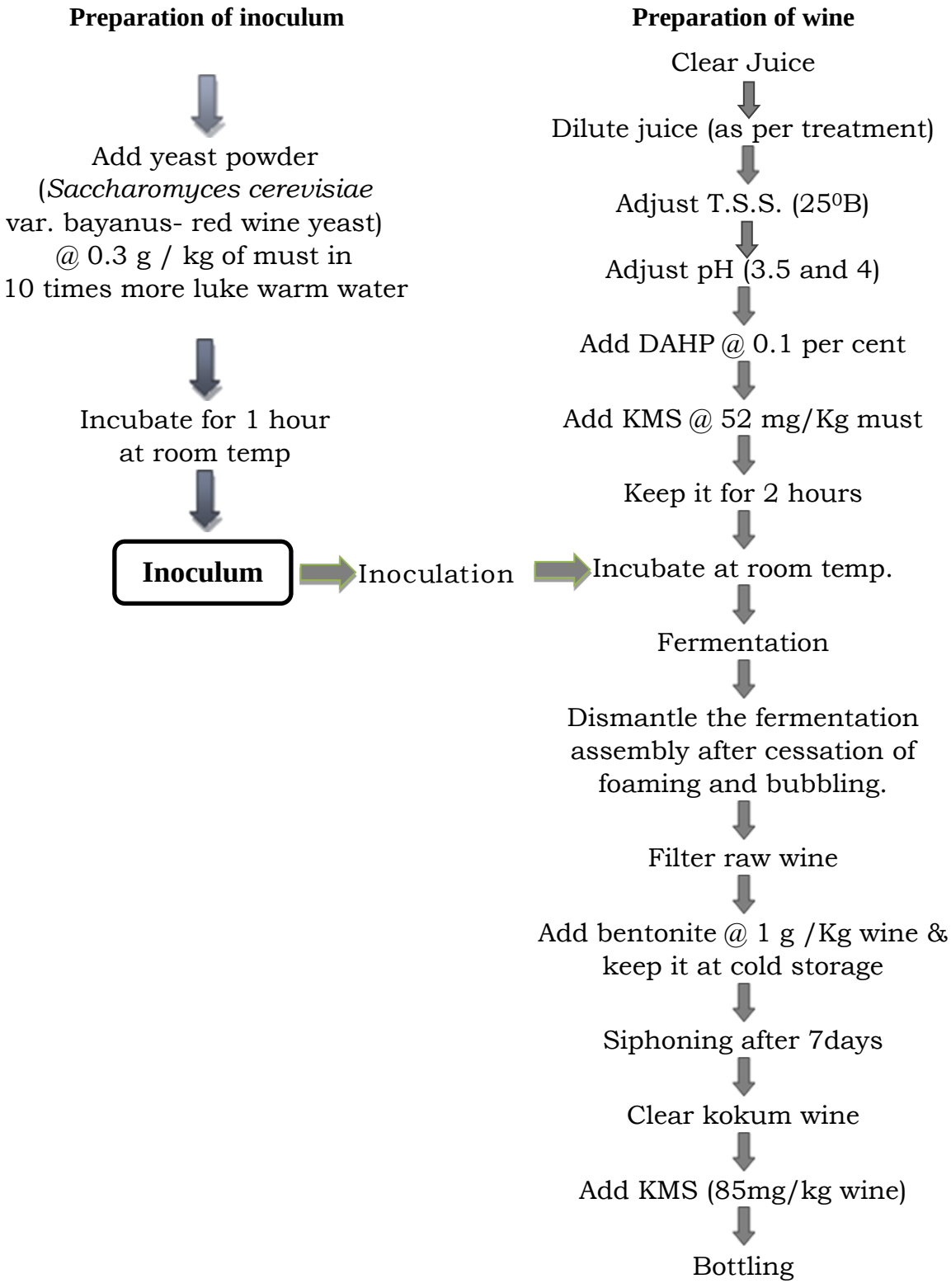


Fig.2 Preparation of wine from kokum juice



With respect to sensory evaluation of kokum wine the highest scores for aroma (12), taste (13), overall acceptability (13) and overall quality (13) were recorded in the interaction D_4P_1 while the highest score for colour and appearance (14) and astringency (13) was observed in the interaction D_5P_1. In case of body interaction D_4P_2 recorded maximum (14) score.

From this experiment it can be concluded that for preparation of standard quality wine from ripe kokum fruits, dilute the juice to 1.0:1.5 proportion (juice : water) and adjust the pH of must to 3.5 (D_4P_1), along with 25^0Brix T.S.S. Commercially acceptable wines can be prepared from the interactions D_2P_1, D_3P_1, D_3P_2, D_4P_2 D_5P_1 and D_5P_2.

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