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Qualitative Changes and Flavour Profile of Banana (*Musa* spp) Wine during Ageing

Sarthak Kiribhaga[1], Saji Gomez[1], Meagle Joseph[1]

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ABSTRACT

Background: Banana is a commercial fruit of many tropical and sub-tropical nations. India is the largest producer of banana in the world. The fruit is a valuable source of carbohydrates, phenolics compounds, minerals and dietary fibre. Due to bumper production, seasonality and market gluts, huge post-harvest losses are recurring phenomena in many banana growing states in India. Hence, the present study was undertaken to evaluate the suitability of some commercial banana cultivars in the development of wine and to evaluate the qualitative changes during ageing.

Methods: Wine was prepared from banana varieties (Poovan, Grand Naine, Yangambi (KM-5), Karpooravalli and Palyankodan) in 1:1 and 1:2 dilutions of pulp and water. The TSS content of the substrate was raised to 20°Brix, followed by addition of yeast @ 1.25 g/l. The must was treated with Potassium Metabisulphite (KMS) @ 0.05 g/L to inhibit the growth of other microorganisms. Fermentation was carried out for 15 days, followed by clarification and subjected to ageing for 2 months.

Result: During ageing of wine, the pH and alcohol content showed an increasing trend whereas titratable acidity, total soluble solids, ascorbic acid and phenols showed a decreasing trend. The flavour profile analysis of wine revealed that ethanol, ethyl hydrogen succinate and glycerin were the major flavour compounds in banana wine. After the completion of ageing, alcohol content of banana wine ranged from 8.40 to 9.64%, phenols were in the range of 40.50 to 56.25 mg 100 g^{-1} and total soluble solids varied between 3.6 and 4.5° Brix. Wine prepared from the Poovan variety had the highest overall acceptability score throughout the ageing period.

Key words: Banana, Biochemical, Flavour profile, Sensory evaluation.

INTRODUCTION

Banana (*Musa* spp.) is one of the economically important tropical fruit crops of India. It ranks first among fruit crops cultivated in Kerala in terms of area and production. In Kerala, banana covers an area of 81530 ha with a production of 122413 MT (NHB, 2020). It is considered a major food crop for millions of people in the world and contributes significantly to food security. Significant losses have been reported in banana due to inadequate post-harvest handling practices. An extensive amount of marketable surplus fruits is accessible in all banana developing areas which should be handled and can be changed into processed products (Talla *et al*., 2004). Browning of banana pulp during processing operations and product development is an undesirable phenomenon which needs to be eliminated. High viscosity and turbidity are other inherent problems associated with banana pulp, which pose problems during clarification of juice. Tapre and Jain (2016) reported that pretreatment of pulp with 1000 ppm of ascorbic acid or heating at 90°C for 6 minutes helped in retention of natural colour of clarified juice without marked changes up to 4 hours of storage at room temperature.

Wine is a product obtained as a result of alcoholic fermentation of fruits rich in natural sugars by yeast with resultant production of ethanol and carbon dioxide. Banana wine is a delicious alcoholic beverage with moderate levels of alcohol in it. As banana is rich source of many phytochemicals and bioactive substances, wine produced from banana is often considered a healthy alcoholic beverage. German and Walzem (2000) are of the opinion that epidemiologic studies from numerous disparate populations reveal that individuals with the habit of daily moderate wine consumption enjoy significant reductions in all-cause and particularly cardiovascular mortality when compared with individuals who abstain or who drink alcohol to excess. Sahni and Shere (2018) reported that fruit and vegetable pomace contains bountiful of bioactive compounds including antioxidants that confer added health benefits. Moreover, utilization of banana for wine making would eliminate post harvest losses and market gluts, besides providing employment opportunities. Hence, the present study aims to evaluate the popular banana varieties of Kerala for wine production and their quality of wine during ageing.

[1]Department of Post Harvest Technology, College of Agriculture, Vellanikkara, Thrissur-680 656, Kerala, India.

Corresponding Author: Saji Gomez, Department of Post Harvest Technology, College of Agriculture, Vellanikkara, Thrissur-680 656, Kerala, India. Email: saji.gomez@kau.in

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MATERIALS AND METHODS

The present investigation was carried out with banana varieties (Grand Naine, Karpooravalli, Poovan, Yangambi (KM-5) and Palayankodan) maintained at the Banana Research Station, Kannara (Kerala Agricultural University) located in Thrissur district of Kerala. The investigation was carried out in the Department of Post Harvest Technology, College of Agriculture (Kerala Agricultural University), Thrissur during 2018-2021.

Preparation of wine

Ripe fruits of banana varieties after removal of peel were sliced into smaller pieces and added with boiled and cooled water in 1:1 and 1:2 ratios (w/v). The TSS content of the substrate was raised to 20°Brix by adding cane sugar, followed by addition of baker's yeast @ 1.25 g/l of must. Extra cane sugar was added to the must raise the TSS to 20°Brix as the TSS declined after dilution with water. The must was treated with (KMS) potassium metabisulphite (0.05 g/l) for the inhibition of other microorganisms. The entire mass was allowed to ferment for 15 days under anaerobic condition in china clay jar, followed by addition of clarifying agent (albumen) at the rate of 40 g for 1 litre and it was filtered after one week. Preliminary trial revealed that wine prepared from the varieties Poovan, Grand Naine, Yangambi (KM-5) and Palyankodan in 1:2 ratio of pulp and water and the wine from Karpooravalli in 1:1 ratio of pulp and water were organoleptically superior. Clarified wine was subsequently kept in china clay jar for ageing, for a period of two months. Quality of wine prepared from the five varieties of banana was evaluated during ageing.

Biochemical characteristics of banana varieties

Ripe fruits of banana from all five varieties selected for wine making (Grand Naine, Poovan, Karpooravalli, Yangambi (KM-5) and Palayankodan) were evaluated for the biochemical characteristics. Total soluble solids (TSS) were determined by using a digital refractometer (PAL 1 and 2, Atago, Japan). Standard digital pH meter was used in determining the pH (Eutech, pH spear).Titratable acidity and ascorbic acid were estimated as per the procedure suggested by AOAC (1998). The titratable acidity was estimated by titrating a known weight/volume of the sample against 0.1 N sodium hydroxide solution using phenolphthalein as an indicator and expressed as per cent malic acid. Ascorbic acid was determined by titrating a known weight of sample with 2, 6-dichlorophenol indophenol dye, using metaphosphoric acid as stabilizing agent. Estimation of total phenols was carried out with Folin-Ciocalteau reagent as described by Asami *et al.* (2003). Optical density values were recorded in a UV- visible spectrophotometer at 650nm (UV-1800 Shimadzu, Japan). The content of total phenols was expressed as mg 100 g^{-1}. Alcohol content was determined from specific gravity (Deng *et al*, 2016).

Flavour profile

GC-MS analysis was performed on a Trace 1300 Gas Chromatograph coupled to a TSQ 8000, Ion-trap mass spectra detector equipped with a fused-silica capillary column TG5MS with 30 m × 0.25 mm id, 0.25 µm film-thickness (Trace 1300, Thermo Fisher Scientific Co., Italy). 1 µl of wine sample was injected. The detector and injector had temperatures 270 and 250°C, respectively and the column oven temperature was maintained at 50°C for 2 min. followed by increment of 3°C/min up to 200°C held for 8 min. and then, with increment rate of 10°C/min. up to 220°C and held for 8 min at the same temperature. The carrier gas was helium, with a flow rate of 1.0ml/min. The ion trap, transfer line and ion source temperatures were maintained at 200°C, 240°C and 210°C, respectively. Head-space volatiles were quantified as relative per-cent area in GC-MS chromatogram and were identified by comparing retention index as determined using homologous series of n-alkanes (C_5 to C_{32}) as the standard (Wang *et al.*, 1994) and comparing the spectra available with spectral library NIST MS Search 2.0.

Sensory and statistical evaluation

Sensory quality of banana wine was judged by a panel of semi-trained judges of different age groups for appearance, colour, flavour, texture, odour, taste and overall acceptability, based on a 9 point hedonic scale rating (Amerine *et al*., 1965). A score of 5.5 and above was considered acceptable. Statistical analysis was conducted using completely randomized design using a two-way analysis of variance (ANOVA). The data was expressed on the basis of mean and standard deviation.

RESULTS AND DISCUSSION

Biochemical characteristics of banana varieties

Banana varieties selected for wine making (Grand Naine, Poovan, Karpooravalli, Yangambi (KM-5) and Palay ankodan) were evaluated for the biochemical characteristics (Table1). Total soluble solids of banana varieties varied from 18 to 22°Brix. The pH of fruits was in the range of 4.12 to 4.72. Ascorbic acid content of banana varieties varied between 2.24 and 2.81 mg 100 g^{-1}. Specific gravity ranged from 1.061 to 1.062.Moisture content was between 71.98 and 84.51%. Ash content varied from 5.36 to 8.65% and protein from 4.79 to 7.62%, whereas fat levels were between 0.61 and 1.36%. These findings are in accordance with those reported by Deshmukh *et al.* (2009) in the variety Grand Naine, Narayana *et al.* (2017) in Poovan and Karpooravalli and Reni (2005) in Grand Naine, Poovan, Palayankodan and Karpooravalli. Higher ash and protein contents in the varieties may be due to lower moisture contents.

Changes in quality of wine during ageing

Preliminary trials revealed that fruit pulp: water ratio of 1: 2 was the ideal proportion for wine preparation in all cultivars except in the cultivar Karpooravalli. This conclusion was arrived at from a previous experiment conducted with all the mentioned varieties with 1:1 and 1:2 ratios of water in the preparation of banana wine. Organoleptic quality attributes were the criteria considered for selection of the

optimum ratios of fruit pulp and water. Therefore, wine made from these combinations of fruit pulp and water in all the five cultivars were selected for ageing process. Alcohol content of banana wine from different varieties ranged from 8.40 to 9.64%, after completion of ageing process. Utilization of sugars by yeast may have led to increase in alcohol content of wine. During alcoholic fermentation, natural as well as added sugars present in fruit juice are consumed by yeast and are subsequently converted into ethanol and carbon dioxide. The content of alcohol in wine varies with the substrate, strain of yeast used and temperature during fermentation, compounds added for growth and multiplication of yeast *etc*. The finding is in agreement with those reported by Holegar *et al.* (2016) in jamun wine and Gavimath *et al.* (2012) in banana wine. The pH of wine showed an increasing trend during the ageing period (Table 2). After 30 days of ageing, wine from Karpooravalli recorded the highest (3.83) pH and the lowest was recorded in wine made from the variety Grand Naine (3.64). Same trend continued till the completion of ageing. Decrease in acidity may have resulted in the increase of pH during ageing. The development of esters from ethyl alcohol and volatile acids might have increased the pH. The increase in pH of wine during ageing was reported by Shanmugasundaram *et al.* (2005) in banana variety Robusta and in guava wine by Shankar *et al.* (2004). Total soluble solids of banana wine decreased throughout the ageing period (Table 2). After completion of ageing, wine from Karpooravalli recorded the highest TSS (4.52°Brix) and the lowest (3.65°Brix) in wine prepared from Poovan. The drop in TSS during fermentation and subsequent ageing may be due to the transformation of sugars into alcohol. Reduction of TSS during ageing was reported in jamun wine (Joshi *et al*., 2012). Titratable acidity of banana wine decreased throughout the ageing period (Table 2). The titratable acidity was highest in wine from Grand Naine (1.12%) and the lowest was recorded in wine produced from Poovan (0.76%), after 30 days of ageing. Same trend was observed up to the completion of ageing. Reduction in titratable acidity during ageing may be due to the precipitation of various acids into their respective salts (Amerine *et al*., 1980). The reduction of titratable acidity during ageing is desirable which makes wine more acceptable (Zoecklein *et al*., 2013). Wine prepared from mahua (*Madhuca longifolia)* showed decreasing trend in titratable acidity during ageing (Yadav *et al*., 2009). The ascorbic acid content of banana wine showed a decreasing trend during ageing period (Table 3). After 60 days of ageing, wine produced from Karpooravalli recorded the highest ascorbic acid (1.90 mg 100 g^{-1}) and

Table 1: Biochemical characteristics of banana varieties.

	TSS (°Brix)	pH	Ascorbic Acid (mg 100 g^{-1})	Titratable acidity (%)	Specific gravity	Moisture (%)	Ash (%)	Protein (%)	Fat (%)
Grand naine	21.0	4.12	2.40	0.39	1.062	84.51	8.65	7.62	0.81
Poovan	20.0	4.71	2.81	0.45	1.061	82.97	6.18	6.76	1.13
Karpooravalli	19.0	4.23	2.54	0.51	1.062	71.98	5.36	4.79	1.36
Yangamby KM-5	22.0	4.33	2.30	0.49	1.061	74.21	7.51	6.52	1.12
Palyankodan	18.0	4.72	2.24	0.54	1.062	78.09	7.24	6.69	0.61
CD	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018

Table 2: Effect of ageing on pH, total soluble solids (TSS) and titratable acidity of banana wine.

Treatments	pH		Total soluble solids (°Brix)		Titratable acidity (%)	
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
T1	3.64	3.73	4.0	3.8	1.12	1.00
T2	3.77	3.80	3.8	3.6	0.76	0.72
T3	3.83	3.85	4.7	4.5	0.92	0.80
T4	3.65	3.69	3.9	3.8	0.83	0.70
T5	3.80	3.82	4.0	3.8	0.86	0.82
CD factor A	0.022		0.223		0.022	
CD factor B	0.014		0.141		0.014	
CD factor A×B	0.032		-		0.032	
SE (±m)	0.01		0.1		0.01	

DAS: Days after storage.

T1- Grand naine banana wine (1:2 pulp and water).

T2- Poovan banana wine (1:2 pulp and water).

T3- Karpooravalli banana wine (1:1 pulp and water).

T4- Yangambi (KM-5) banana wine (1:2 pulp and water).

T5- Palyankodan banana wine (1:2 pulp and water).

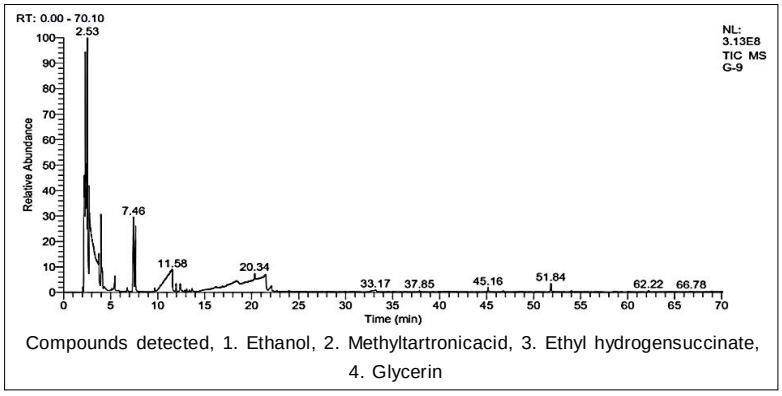
the lowest was noticed in wine from Yangambi and Grand Naine (1.60 mg 100g^{-1}). Reduction in ascorbic acid content was likely caused by heat or oxidation destruction. The results confirm the findings of Akubor *et al.* (2003) in banana wine, Nikhanj and Kocher (2015) in guava wine and Yadav *et al.* (2009) in mahua*(Madhuca longifolia*) wine. Phenols in banana wine declined during ageing (Table 3). The wine prepared from Yangambi recorded the highest (73.25 mg 100 g^{-1}) phenol content and the lowest (52.00 mg 100 g^{-1}) was recorded in wine from Grand Naine, after 30 days of ageing. Similar trend was noticed up to the completion of ageing process. Reduction in phenol content of wine during ageing is due to breakdown of polyphenols to isoprenoid (Jackson, 2008). Decreasing trend of phenols during ageing was reported in *jamun* wine (Joshi *et al*., 2012) and guava wine (Nikhanj and Kochar, 2015). Alcohol content of wine prepared from all varieties of banana increased throughout the ageing period (Table 3).

Flavour profile

Ethanol, ethyl hydrogen succinate and glycerin were common compounds that were detected in wine from all varieties (Fig 1, 2, 3, 4 and 5). Phenyl ethyl alcohol was absent in Grand Naine whereas, it was present in all other wines. Wine from Grand Naine and Yangambi (KM-5) had similar compound methyltartronic acid. 1-Deoxy-d-arabitol in the wine from Karpooravalli, 1-Butanol-3-methyl (isoamyl alcohol) in the wine from Poovan and 3 (p-hydroxyphenyl) 1-propanol were the unique compounds detected in the wine from these varieties. The major compounds detected during GCMSMS analysis of wines had pleasant aroma. The aroma descriptors of the compounds detected during analysis revealed that all these compounds were aromatically pleasing. The results showed that wine from all varieties had major compounds like ethyl hydrogen succinate and phenyl ethyl alcohol, two highly odorous compounds which may have given the wine delightful aroma. Deng *et al.* (2016) reported that the major portion of composite wine of banana and orange was composed of alcohols and esters, which had the special, pleasant aroma. Similar aroma compounds were detected in banana wine (Ranjitha *et al*., 2013).

Sensory evaluation

Organoleptic properties differed markedly in wine from all varieties (Fig 6 and 7). Wine from Poovan retained higher organoleptic scores throughout ageing. After the completion of ageing also, wine produced from Poovan had the highest overall acceptability score (7.6) and the lowest (5.9) was recorded in wine produced from the varieties Karpooravalli and Yangambi. The flavour profile of wine from Yangambi revealed the presence of methyltartonic acid, which may have contributed to the unpleasant smell in this wine which is absent in the wine from Poovan. The higher overall

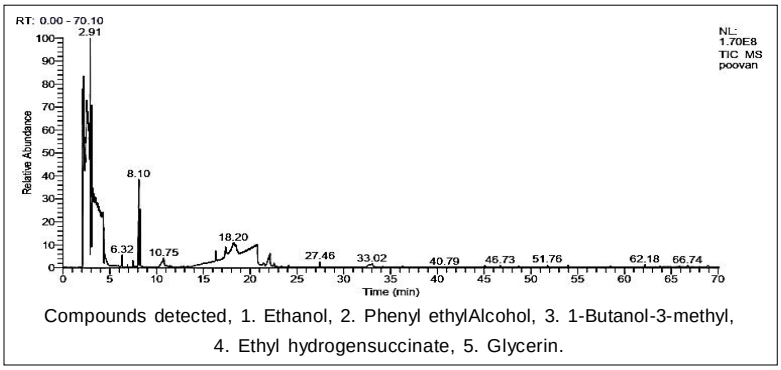


Compounds detected, 1. Ethanol, 2. Methyltartronicacid, 3. Ethyl hydrogensuccinate, 4. Glycerin

Fig 1: Flavour profile of GCMSMS analysis of wine from banana cv. Gr and Naine.

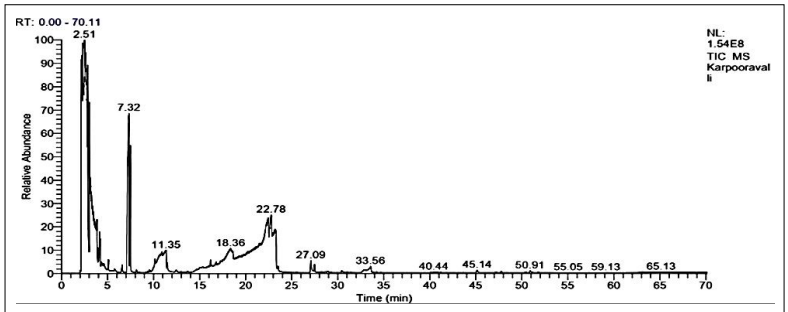
Table 3: Effect of ageing on ascorbic acid, phenols and alcohol content of banana wine.

Treatments	Ascorbic acid (mg 100 g^{-1})		Phenols (mg 100 g^{-1})		Alcohol (%)	
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
T1	1.65	1.60	52.00	40.50	8.33	8.40
T2	1.99	1.91	53.50	44.25	9.45	9.47
T3	1.98	1.90	66.37	41.37	9.28	9.36
T4	1.66	1.60	73.25	56.25	9.56	9.57
T5	1.74	1.68	52.50	42.25	9.52	9.64
CD factor A	0.022		0.705		0.064	
CD factor B	0.041		0.446		0.041	
CD factor A×B	-		0.997		-	
SE(±m)	0.010		0.316		0.029	



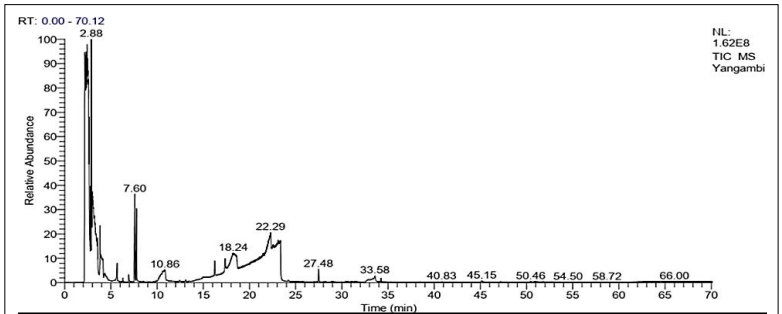
Compounds detected, 1. Ethanol, 2. Phenyl ethylAlcohol, 3. 1-Butanol-3-methyl, 4. Ethyl hydrogensuccinate, 5. Glycerin.

Fig 2: Flavour profile of GCMSMS analysis of wine from banana cv. Poovan.



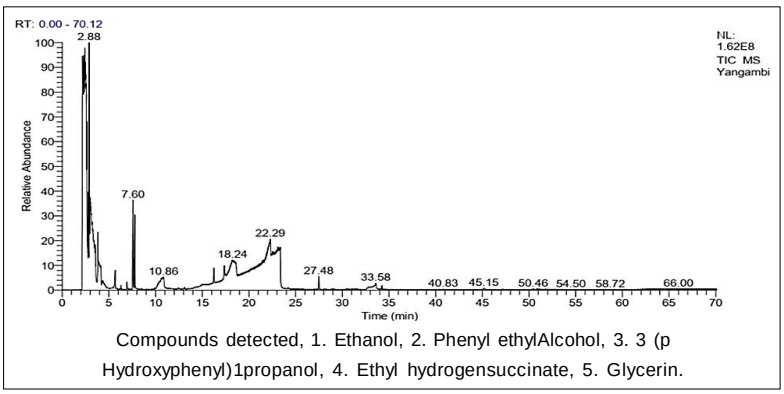
Compounds detected, 1. Ethanol, 2. Phenyl ethylAlcohol, 3. 1-Deoxy-d-arabitol, 4. Ethyl hydrogensuccinate, 5. Glycerin.

Fig 3: Flavour profile of GCMSMS analysis of wine from banana cv. karpooravalli.



Compounds detected, 1. Ethanol, 2. Methyltartronicacid, 3. Ethyl hydrogensuccinate, 4. Glycerin, 5. Phenyl ethylAlcohol.

Fig 4: Flavour profile of GCMSMS analysis of wine from banana cv. yangambi (KM-5).



Compounds detected, 1. Ethanol, 2. Phenyl ethylAlcohol, 3. 3 (p Hydroxyphenyl)1propanol, 4. Ethyl hydrogensuccinate, 5. Glycerin.

Fig 5: Flavour profile of GCMSMS analysis of wine from banana cv. palayankodan.

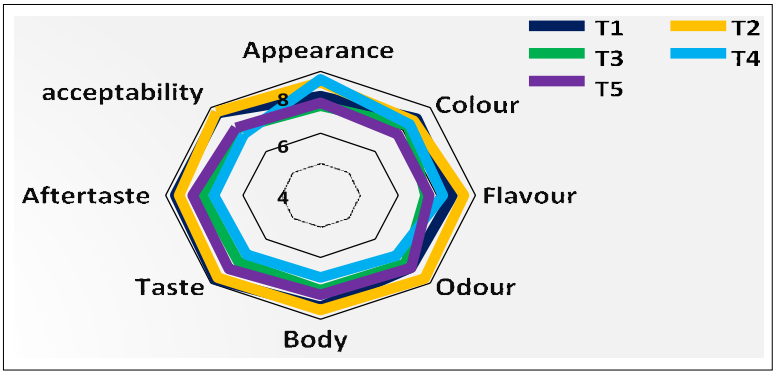


Fig 6: Effect of ageing (30 DAS) on sensory attributes ofbananawine.

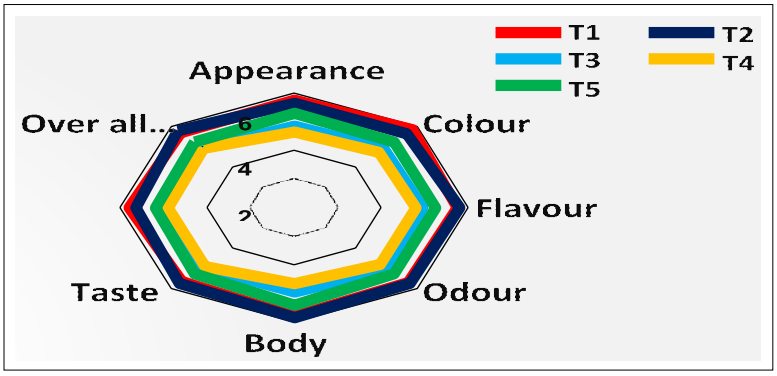


Fig 7: Effect of ageing (60 DAS) on sensory attributes of bananawine.

Plate 1: Banana varieties used for wine preparation.

Plate 2: Wine from Grand Naine, Poovan, Karpooravalli, Yangambi and Palayankodan.

acceptability score of wine from Poovan may be due to the unique flavouring compounds and lower titratable acidity which might have given it the distinct flavour properties. Increase in sensory scores of wine during ageing may be because of the positive effects of the resultant biochemical reactions (Plates 1 and 2). Improvement in sensory properties was also reported in strawberry wine (Sharma and Joshi, 2003) and in sapota wine (Pawar, 2009), during ageing.

CONCLUSION

During ageing of wine, the pH and alcohol showed an increasing trend whereas titratable acidity, total soluble solids, ascorbic acid, phenols. The flavour profile analysis of wine revealed that ethanol, ethyl hydrogen succinate and glycerin were the major compounds in banana wine. The wine from Poovan had a unique compound, 1-Butanol-3-methyl. The wine produced from Karpooravalli contained 1-

Deoxy-d-arabitol in addition to other major compounds. The wine produced from Yangambi also contained methyltartronic acid. The wine made from Palayankodan had a distinctive compound 3 (p-hydroxyphenyl) 1-propanol. After completion of ageing, wine from the variety Poovan had the highest organoleptic score (7.6),which had an alcohol content of 9.47%, pH (3.8), total soluble solids(3.6°Brix), ascorbic acid (1.99 mg 100 g^{-1}), total phenols (44.25 mg 100 g^{-1}) and titratable acidity of 0.72% .

Conflict of interest

All authors declare that they have no conflict of interest.

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