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Country-wine making from Eembe fruit (*Berchemia discolor*) of Namibia

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Abstract

Country-wine was made from dried Eembe fruit purchased from Katima Mulilo open market using commercial wine yeast. The fruit produced a wine with 8.6% alcohol content when no sugar was added. Fermentation to produce the wine was carried out at 22°C. The clarity, aroma, colour and acceptability of the wine was aided by the addition of sulphur dioxide. The addition of sugar to the must produced from the dried fruit increased the alcohol content of the wine and all the batches produced dry wine.

Introduction

Production of alcoholic beverages from fruit juices other than grape juice is not new (Rodin, 1985; Maud, 1990;

Lear 1995, Leaky *et al.*, 1996, Ngwira, 1996; Singh *et al.*, 1998). Traditionally, ripe fruits are mashed in water in large containers and allowed to ferment with the available wild yeasts found in the skin of the fruits. Once fermentation is complete, as evidenced by the absence of bubbling in and above the alcoholic product, the beverage is strained and is immediately ready for drinking (Rodin, 1985). Industrial processing of wine is more elaborate than this (Johnson, 1987; Ough, 1989; Owen, 1989; Macrae *et al.*, 1993; Jackson, 1994; Ewart, 1995; Paterson, 1995; Vine *et al.*, 1997; Frederick, 2000)

In Northern Namibia the most popularly consumed country-wine is made from Marula fruit (*Sclerocarya birrea*). Fruits from other veld trees are also used when the fruits are ripe. Sometimes the beverages are distilled into strong spirits.

Eembe (*Berchemia discolor*) which grows in Namibia, is also known to grow elsewhere in Africa stretching from Ethiopia to South Africa. The fruits are small drupes, usually 4-8mm wide and up to 20mm long. The fruits tend to become yellow when ripe. They have a sweet, pleasant flavour. When the harvest is abundant, the excess fruit is collected and dried usually in the sun for later use. In some cases the fruit is pounded into cake either for immediate consumption or at times dried and stored for later use (Venter and Venter, 1996; Palgrave 1984)

In wine making, the alcohol content, as well as the sweetness or dryness and acidity of the finished product depend on the original sugar content of the must as well as the type of yeast used in the fermentation process. Routinely, the common sugar (sucrose) can be added to the must, in order to increase the alcohol content and/or the sweetness of the end product. The addition of sugar has been shown by Jackson (1994) to mellow the acidity and bitterness of the resulting wine by the interaction of the sugar with the organic acids as well as the tannins especially in the red wines. Sugar additions have been used by both Jackson (1994) and Vine *et al.*, (1997) to improve the "body" of the resulting wine by increasing the "heaviness" of the wine (organoleptic test).

Although the use of the natural yeasts found on the fruits is the norm in the rural areas where alcoholic beverages are made from the marula fruits, it is advisable to use proven yeasts in order to reduce the risk of unwanted fermentation products. It is therefore important that all the other yeasts be eliminated first before the proven yeasts are introduced in the must. One of the popular methods for controlling the unwanted yeasts has been the use of sulphur dioxide (camden tablets). The sulphur dioxide, acts as a sterilizing agent and can be added to the must before starting fermentation (Vine *et al.*, 1997 and Frederick, 2000) as well as at the end of fermentation especially during the bottling process (Ough, 1989, and Frederick, 2000). Although this sulphur dioxide is acceptable as a sterilizing compound, its addition in excess, results in imparting very unpleasant flavours and aromas (Johnson

1987, and Vine *et al.*, 1997). The sulphur dioxide has been applied even at the first racking in order to replace the carbon dioxide lost and protect the wine from oxidation (Paterson, 1995 and Frederick, 2000). Sulphur dioxide is normally used during bottling where there are no sterile filters to prevent non-enzymatic browning which normally spoils the colour of the white wine.

The amount of added sulphur dioxide depends on the pH of the must and wine. According to Jackson (1994), the wines or musts of pH 3.2 require less sulphur dioxide (20-30 mg/L at racking and 30-40 mg/L at bottling) than the wines or musts of pH 3.5 (80 mg/L at both times). The recommended sulphur dioxide levels for good wines is 35-50 mg/L. This recommended rate may change depending on the levels of anthocyanins, tannins, pyruvic acid as well as sugars and sugar acids available in the must (Vine *et al.*, 1997). Thus red wines will mostly be affected.

Objective of the project

The main objective of the project was to investigate the possibility of making organoleptically acceptable white wine from Eembe fruit juice, from Northern Namibia, using commercially available wine yeast . The effect of sulphur dioxide on the wine produced was also investigated in trying to improve on the sensory qualities of the product.

Materials and methods *Materials*

Dried Eembe fruits were purchased from the open market at Katima Mulilo where it was available in abundance. Pure wine yeast was purchased from Boots Chemical company in the UK (CWE Ltd. England). Pectolase enzyme for wine clarification and wine yeast nutrient (Diammonium Phosphate and Ammonium Phosphate), cambden tablets containing 93% Sodium metabisulphite ($\text{Na}_2\text{S}_2\text{O}_5$:190.10, or 68.81% SO_2), shrinkable plastic bottle stoppers were also obtained from Boots Chemical Company in the UK. PVC containers of 20 liters capacity were obtained from a Windhoek Supermarket whereas 2 liter PVC bottles for some of the fermentation experiments were obtained from Coca Cola Ltd in Windhoek Food grade citric acid and wine bottles were also purchased locally in Windhoek.

Sterilization of Equipment

All the equipment and utensils used were cleaned with detergent and rinsed several times with water to remove any traces of the detergent. The final rinsing was carried out using sodium metabisulphite solution at the concentration

of 28.0g/500 ml of water. The equipment and utensils were again rinsed with distilled water soon before use.

Juice Extraction

The dried Eembe fruits were thoroughly cleaned with cold water in 20 liter containers. The mixture of fruit and water was agitated manually in order to dislodge any adhering dirt and the water was discarded three times.

After washing, the fruit were placed in the 20 liter containers which had been sterilized and warm water at 70-75°C was added and the fruits were soaked overnight and during the process the temperature was reduced to 22°C. After soaking overnight, the fruit was mashed and the volume from 5kg fruit was adjusted to 20 liters. To this must, 100 g of pectolase was added and stirred in order to thoroughly incorporate the enzyme into the must. The must was then left overnight at 22°C for the pectolase to hydrolyze the pectin in the must and enhance fruit juice extraction as well as improve wine clarification. The final extraction was carried out using a grating unit of a Black and Decker FP31 Shortcut Home Food Processor. Care was taken not to crack the seeds in order to reduce the level of phenolic compounds in the must.

After extraction, the must was strained to remove seeds from the must. More pectolase (40g/20 liters) was added and the must left to stand overnight at 22°C to allow for more pectin to be hydrolyzed and release the trapped juices at the same time enhance conditions for better wine clarification after fermentation. The resulting must was filtered using muslin cloth and the resulting must was tested using a glass hydrometer for its potential sugar content hence the potential alcohol content upon complete fermentation (values obtained from a chart).

Table 1

Aerobic Fermentation

The pH of the must was adjusted from 2.8 to 3.3 using a 10% food grade citric acid solution. Wine yeast nutrient was added at the rate of 9g/20 liter must. The wine nutrient and yeast mixture was initially activated for 2 days at 22°C in a 1 liter conical flask container with 500 ml sterilized water and 2g of pure wine yeast nutrient. The container was then loosely covered with cotton wool and left to stand for 5 days at 22°C to allow for aerobic fermentation to take place. Immediately after the five days the must was racked and the resulting must was placed in separate 2 liter containers having different levels of sulphur dioxide (cambden tablet powder) as well as different levels of sugar additions. The 2-liter containers were then fitted with anaerobic glass air-locks for

anaerobic fermentation. These containers were filled to 1.0 cm from the top of the container.

Anaerobic Fermentation

Design of the treatments

Four levels of sugar content and four levels of sulphur dioxide additions were used, hence a 4 x 4 factorial design was used. The sugar addition levels investigated were: 0.00; 50.0; 100; and 150 g/2 liters while the sulphur dioxide levels investigated were: 0.00; 0.25; 0.50 and 0.75 tablets/2 liters (corresponding to 0.0; 155.0; 310 and 465.0 mg SO₂/2 liters of the crushed tablet powders). The air-locks did not allow oxygen to enter the container but allowed CO₂ to escape to the atmosphere and were topped up with water every day.

The anaerobic fermentation took a minimum of three months and during this time the wine was racked after every two weeks in order to avoid spoilage of the wine as a result of lying on the spent yeast sediment. From three months onwards, the wine was ready for bottling since fermentation had ceased. However, filtration was necessary in some cases because of the cloudiness of the resultant wine.

Sensory Evaluation

Sensory evaluation of the bottled wine was carried out during two separate days. A modified Davis Score Card was used (Jackson, 1994). The panelists were requested to give preference scores to a set of sensory properties, as in **Table 2**, of the various samples of wine against a control wine being guided by the criteria outlined on the sensory evaluation score card. The score so obtained were subjected to statistical analysis using a Statistical Program for Social Sciences (SPSS) for Windows version 8.0.

Results and Discussion

The initial hydrometer specific gravity readings for the freshly extracted must averaged 1.064, which on the standard table represented 169 g sugar per liter of must. In turn this represented a potential alcohol content of 8.6% (Vine *et al* 1997). The addition of 50, 100 and 150 g sugar per 2 liters of must was equivalent to a potential extra alcohol content of 1.6, 2.3 and 3.7% respectively. This gave the total alcohol content of 10.2, 10.9 and 12.3% respectively in the 50, 100 and 150 g sugar additions to the 2 liter containers whereas the control remained at 8.6%

alcohol.

Fermentation process in all the containers and therefore all the treatments was complete since the hydrometer specific gravity readings were all 1.00 which is the specific gravity of pure water. Thus the wines were all "dry" wines. This conclusion was confirmed by the organoleptic evaluation. The control, although low in alcoholic content produced acceptable white wine as scored by the panel.

The results indicated that the colour, aroma and flavor were enhanced by the addition of sulphur dioxide during the fermentation process. There was also a significant reduction in the bitterness and vinegariness of the wine when sulphur dioxide was added during the fermentation process, as scored by the panelists. However, the acidity of the wine was not affected by the addition of the sulphur dioxide or sugar to the must during fermentation. The addition of sugar did not affect most of the properties monitored i.e. aroma, flavour, bitterness or vinegariness.

The interaction between sulphur dioxide and sugar additions during fermentation did not have any statistically significant influence on the wine characteristics discussed above. However wine clarification was more pronounced as more sulphur dioxide and sugar were added to the must during fermentation.

This was attributed to the bleaching ability as well as the inhibition of non-enzymatic browning of the sulphur dioxide especially at higher concentrations (Johnson 1987; Jackson 1994; Vine *et al.*, 1997)

The wine samples in which no sugar had been added produced a darker and cloudier appearance, confirming the view that sugar plays a positive role in the chemical reactions during the fermentation process associated with the general improvement in the appearance of the wine. The interaction between sugar and sulphur dioxide gave no significant results indicating their independent action during the fermentation process.

The panelists used were fairly new to the techniques. However the platform served as a training ground for future panelists. Similar observations were made by Ough (1992) and Vine *et al.*, (1997).

Table 2

Conclusions

The current study has indicated that it is possible to use dried Eembe fruit in the production of country wine of

acceptable standard. It would therefore not be a waste of the fruit if it were bought in dried form for later use. In the event that transportation of the ripe fruit proves difficult, it is recommended that the fruit be dried at the place of harvesting and later utilized in fermentation in wine making.

It has also been shown that the addition of sulphur dioxide at the level of 155-310 mg/2 liters improves all the organoleptic qualities tested in this research. The sugar level of the must should be such that it gives the alcohol level of 10.9-11%, a level which had the highest score by the panelist although this was not statistically significant.

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Appendix 1

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Appendix 1. Specific gravity, sugar content equivalent and alcohol content equivalent

Specific Gravity	Sugar (g) per liter	Potential Alcohol Content (%)
1.010	12	0.9
1.015	28	1.6
1.020	43	2.3
1.025	59	3.0
1.030	71	3.7
1.035	91	4.4
1.040	107	5.1
1.045	119	5.8
1.050	131	6.5
1.055	143	7.2
1.060	157	7.8
1.065	169	8.6
1.070	181	9.2
1.075	193	9.9
1.080	207	10.6
1.085	224	11.3
1.090	237	12.0
1.095	250	12.7
1.100	262	13.4
1.105	274	14.1
1.110	287	14.9
1.115	299	15.6
1.120	311	16.3
1.125	323	17.0
1.130	336	17.7
1.135	348	18.4

Source: Wine and beer glass hydrometer manual (The Boots Company PLC Nottingham England).

Table 1. Design of treatments of Eembe must with sugar and sulphur dioxide for the anaerobic fermentation during wine making

2-Liter Container	Sugar level(g/2 liters)	Cambden Tablets/2 liters	Remarks
1	0.00	0.00	No Control
2	50.00	0.00	Effect of Sugar
3	100.00	0.00	
4	150.00	0.00	
5	0.00	0.25	Effect of SO ₂
6	0.00	0.50	
7	0.00	0.75	
8	50.00	0.25	
9	50.00	0.50	50 g Sugar and SO ₂ Interaction
10	50.00	0.75	
11	100.00	0.25	
12	100.00	0.50	100 g Sugar and SO ₂ Interaction
13	100.00	0.75	
14	150.00	0.25	150 g Sugar and SO ₂ Interaction
15	150.00	0.50	
16	150.00	0.75	

0.25 Cambden Tablet/2 liters of must = 155 mg SO₂/ 2 liters of must

0.50 Cambden Tablet/2 liters of must = 310 mg SO₂/ 2 liters of must

0.75 Cambden Tablet/2 liters of must = 465 mg SO₂/ 2 liters of must

The sugar added was in addition to the one naturally present in the fruit juice.

Table 2. Statistical results of the sensory evaluation on some wine characteristics as influenced by the addition of different amounts of SO₂ and Sugar during the fermentation process.

Sensory Characteristic	Source of Variation	F-Calculated	F-Tabulated P ≤ 0.05
Appearance	Sulphur Dioxide	26.277	2.76
	Sugar	3.509	2.76
	Interaction	1.274	2.04
	Panelists	6.520	2.52
Colour	Sulphur Dioxide	6.781	2.76
	Sugar	0.790	2.76
	Interaction	0.838	2.04
	Panelists	7.857	2.52
Aroma	Sulphur Dioxide	5.441	2.76
	Sugar	0.000	2.76
	Interaction	0.803	2.04
	Panelists	6.618	2.52
Flavor	Sulphur Dioxide	2.710	2.76
	Sugar	0.841	2.76
	Interaction	2.274	2.04
	Panelists	5.187	2.52
Sweetness	Sulphur Dioxide	3.440	2.76
	Sugar	0.230	2.76
	Interaction	0.795	2.04
	Panelists	9.810	2.52
Bitterness	Sulphur Dioxide	4.711	2.76
	Sugar	0.964	2.76
	Interaction	1.772	2.04
	Panelists	22.025	2.52
Acidity	Sulphur Dioxide	2.542	2.76
	Sugar	0.621	2.76

	Interaction	0.282	2.04
	Panelists	14.153	2.52
Vinegariness	Sulphur Dioxide	3.745	2.76
	Sugar	1.930	2.76
	Interaction	1.140	2.04
	Panelists	3.040	2.52
General Quality	Sulphur Dioxide	11.126	2.76
	Sugar	1.060	2.76
	Interaction	1.118	2.04
	Panelists	3.543	2.52