Biosci. Biotech. Res. Asia Vol. **3,** No.(**1**) 21-28 (2005)

PHYSICOCHEMICAL DETERMINATION AND SENSORY EVALUATION OF WINE PRODUCED FROM SELECTED TROPICAL FRUITS

F. C. Akharaiyi and F. O. Omoya

Microbiology Department, Federal University of Technology, P.M.B. 704 Akure (Nigeria)

(Received February 25, 2005; Accepted May 19, 2005)

ABSTRACT

The fruit wines were produced in duplicates using mixed and monoculture fermentation techniques. At every 24 hours during fermentation, some quantities of the fermenting wines were withdrawn for physicochemical determination. In the fermenting media, a general decrease in the pH value was observed along days of fermentation and was higher in the monoculture media. Alcohol content % (vol/vol) was also higher in the monoculture media. The total titratable acidity (TTA) increased in the fermenting wine media. The sensory evaluation of the finished wines showed significant differences ($p \leq 0.05$) in colour, taste, aroma and overall acceptability. The watermelon - pineapple wines of both mixed and monoculture fermented were the most favoured in colour, taste, aroma and overall acceptability followed by watermelon - banana and was least in watermelon wine.

Keywords: Physicochemical determination, sensory evaluation, wine and tropical fruits.

INTRODUCTION

Fermentation is the incomplete oxidation of organic products usually sugars into alcohol and carbon dioxide. Microorganisms are fundamental to the wine making process. To understand their contribution, it is necessary to know the biochemical activities of these microbial species and how such activates determine the physicochemical properties of wine, the influence of wine-making practices upon microbial growth and activity; and the combined impact of microbial action and process influences on sensory quality and consumer acceptability of the wine (Doyle, 1997). As a result of yeast metabolism during fermentation, the wine yeast produced a wide variety of compounds beside ethanol, as the main product. The compounds are higher in alcohols, ketones, aldehydes, fatty acids, acetates and ethyl esters (Shreier, 1979). These compounds are released into the fermenting medium and contribute to wine flavour, so that wine quality depends on the kind of compounds and concentrations at which they are present (Herraiz, *et al.,* 1990).

Traditionally, alcoholic fermentation is conducted in large baskets, large wooden barrels or boxes, plastic containers and concrete tanks, but most modern wineries now use relatively sophisticated stainless steel tanks with facilities for temperature control (principally cooling) cleaning in place and other features of process management (Davis, 1993; Boulton, *et al.,* 1995). white wines are generally fermented at 10-18°C for 7 to 14 days or more, where the lower temperature and slower fermentation rate favor the retention of desirable volatile flavor compounds. Juices and wine of high pH (*e.g.* 4.0) have been spoilt by growth of *Clostridium butyricum* and have elevated concentration of butyric acid, isobutyric acid, propionic acid and acetic acid (Sponholz, 1993).

Watermelon is a warm season crop and grows well at high temperature at means of greater than 21°C and can be fermented into alcoholic beverage (Yamaguchi, 1983). Banana are valued mainly for its edible fruit, which can be eaten raw or cooked, or processed as a wide variety of products (FIIRO, 1989). Pineapple is strictly tropical plant with main carbohydrates of sucrose, fructose and glucose (Ihekoronye and Ngoddy, 1985). This work is carried out to determine physicochemical properties of fruit wines during fermentation using mixed and monoculture techniques and the sensory evaluation of the finished wines.

MATERIAL AND METHODS

Source of Materials

Watermelon (*Citrullus lunatus* Thunb.), Banana (*Musa sapientum*) and pineapple (*Ananas comosus*) were purchased in Akure, Ondo state, Nigeria and Brewer's yeast (*Saccharomyces cerevisiae*) was obtained from International Breweries Plc, Ilesa, Osun State.

Preparation of Musts

The first treatment set up involved a homogenate of 800g each of watermelon. The 2nd treatment contained 800g each of homogenized watermelon and banana while the 3rd treatment was a homogenate of 800g each of watermelon and pineapple. However, each of the treatments was replicated for (monoculture and mixed culture) fermentations.

Fermentation Process

The fermentation were carried out at room temperature of 28±2^{0}C. In the mixed culture fermentation indigenous microflora of the fruits were allowed to carry out the fermentation while in the monoculture fermentation, brewer's yeast was seeded solely to carry out the fermentation. The monoculture fermented musts were treated with 50µg/ml of sulphur dioxide to inhibit indigenous microflora before seeding with 3.61 log (cfu) m^{-1} brewer's yeast. The fermentation was then allowed for five days.

Determination of physicochemical changes in the fermenting medium.

Physical and chemical changes were determined during fermentation. The parameters looked at were pH, titratable acidity, alcohol content and sensory evaluation.

Total titratable acidity:

Twenty-five ml of wine samples were boiled in conical flasks and 3 drops of 1% phenolphtatein was added as an indicator. The content was mixed thoroughly in the flasks and then titrated against 0.1 M NaOH. The end point was recorded when the pink colour was noted. The titratable acidity was then calculated as lactic acid.

volume of 0.1m NaOH x Factor x 100
volume of weight sample used in titration (ml),

Table - 1: Means scores of wine samples

Sample Code	Colour	Taste	Aroma	Overall Acceptability
Wmmo	5.78ab	5.67a	5.67ab	5.56a
Wmm	6.22ac	5.33a	5.22b	5.56a
WmBmo	6.78cde	6.11a	6.44ac	6.44bc
WmBm	6.33ad	5.89a	6.33ac	6.22ac
WmPmo	7.44e	8.00b	8.33d	8.00de
WmPm	7.56e	7.11b	7.33cd	7.22be

• Mean followed by the same letter within each column are not significantly different at $p \leq 0.05$ level of significance

Key:

Wmmo = Watermelon wine using monoculture.
Wmm = Watermelon wine using mixed culture.
WmBmo = Watermelon-Banana wine using monoculture.
WmBm = Watermelon-Pineapple wine using mixed culture.
WmPmo = Watermelon- Pineapple wine using monoculture.
WmPm = Watermelon- Pineapple wine using mixed culture.

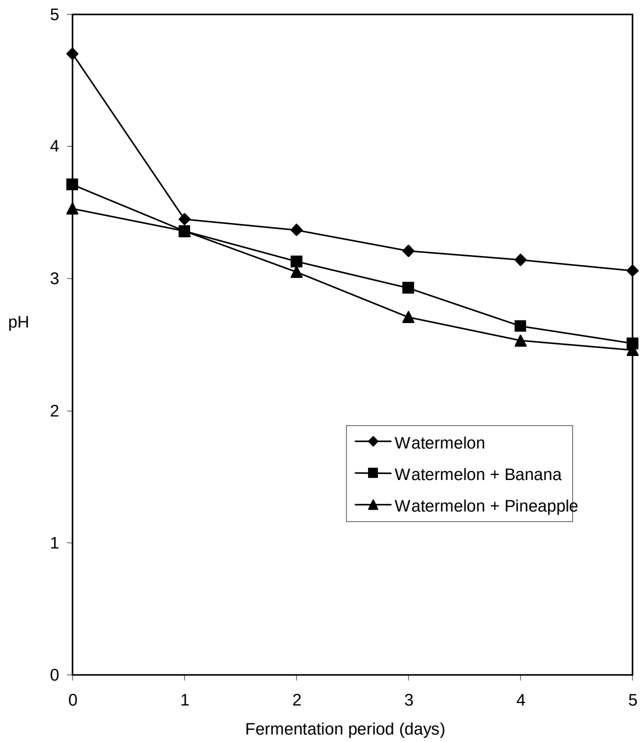

Fig. - 1: Changes in pH during fermentation of fruits using mixed culture

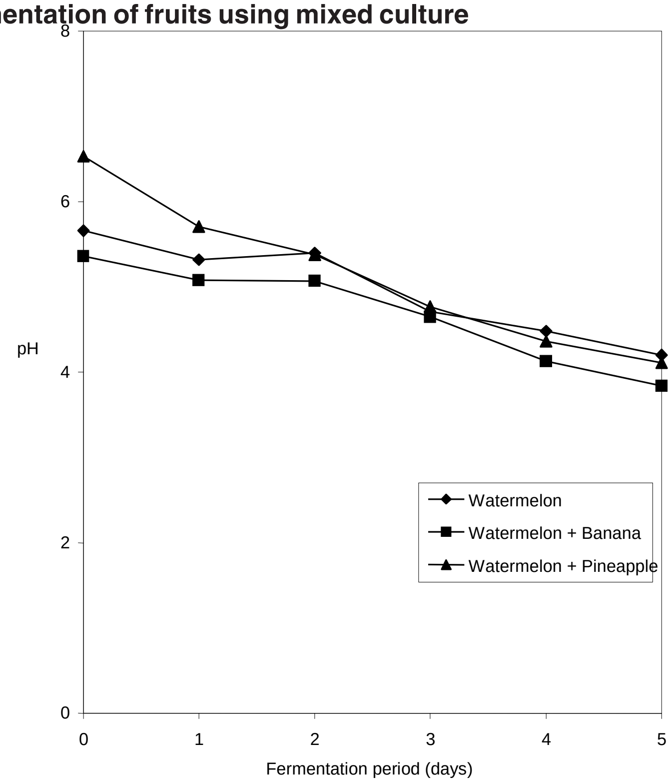

Figure 2: Changes in pH during fermentation of fruits using monoculture.

Fig. - 2: Changes in pH during fermentation of fruits using monoculture

Fig. - 3: Changes in Total Titratable acidity (%) during fermentation of fruits using mixed culture

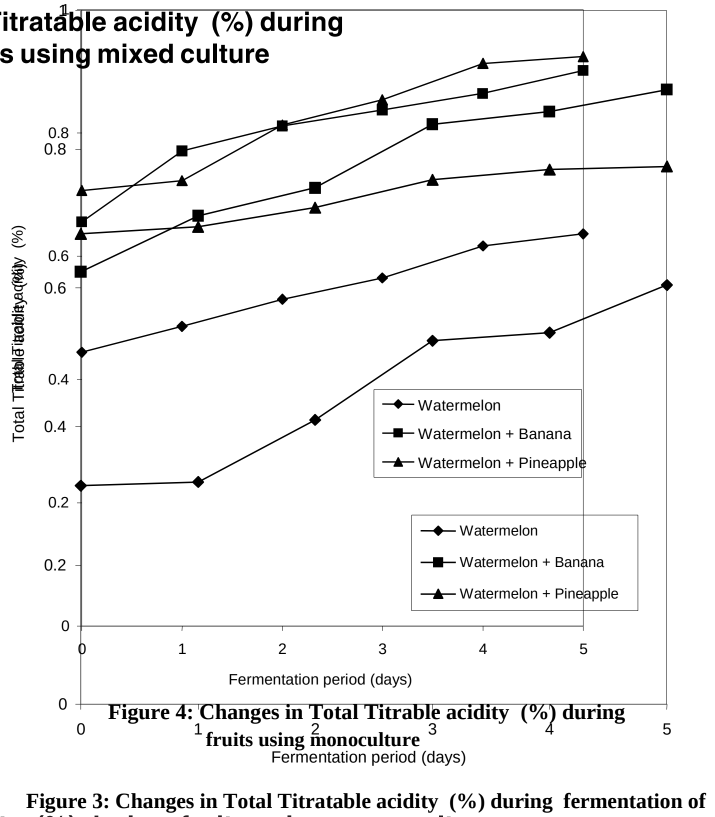

Figure 4: Changes in Total Titrable acidity (%) during fruits using monoculture

Figure 3: Changes in Total Titratable acidity (%) during fermentation of fruits using mixed culture

Fig. - 4: Changes in Total Titrable acidity (%) during fruits using monoculture

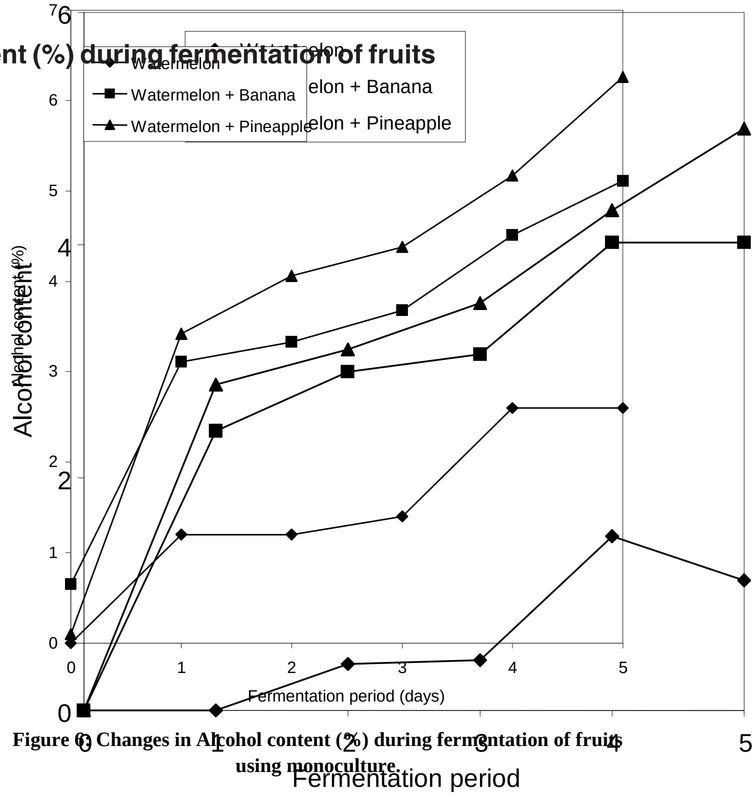

Fig. - 5: Changes in Alcohol content (%) during fermentation of fruits

Fig. - 6: Changes in Alcohol content (%) during fermentation of fruits using monoculture

using mixed culture

Alcohol contents (%)

At every twenty-four, alcohol content was determined in the musts using alcohol meter (Mettler Toledo, England). This was simply done by immersing the alcohol meter into 20ml of the must samples. The percentage alcohol was read off from the stem of the meter.

pH determination

10ml of the must samples was dispensed into small beaker of 50ml capacity and the pH was determined with a pH meter (Griffin, England) after standardizing with buffer 4 and 7 solutions.

Sensory Evaluation

Parameters such as colour, tastes, and overall acceptability were assessed by Nine trained panelists. Multiple comparison test (Ihekonroye and Ngoddy, 1985) was adopted for the evaluation. The average of three replicates of the assessment was calculated while the most preferred samples for each of the samples characteristics were determined using analysis of variance (ANOVA).

RESULTS

Generally, physical changes were observed in the fermentators where the mashed substrates were well separated from the juice by settling at the bottom of the fermentors at initial stage of the fermentation but floated on the juice at the second day of fermentation. Bubbles and foams were as well observed in the various fermenting medium. The pH of the watermelon mixed culture fermenting media was between 3.06-4.70; watermelon-banana mixture had a pH of between 2.50-3.71 while that of watermelon-pineapple mixture was between 2.46-3.53 (Fig. -1). In the monoculture media there was decrease in pH alongside days of fermentation where watermelon fermenting medium, pH ranged between 4.20-5.66, in the watermelon-banana mixture it was between 3.84-5.36 and in the watermelon-pineapple mixture it was between 4.11-6.53 (Fig. -2).

Changes in total titratable acidity (%) was observed in the mixed culture. The total titrable acidity of watermelon fermenting medium, it was between 0.301-0.604%, in watermelon-banana mixture medium, was recorded as 0.623-0.886% while in the watermelon-pineapple mixture it was between 0.678-0.775% (Fig. -3). In the monoculture fermentation, similar changes to those of the mixed cultures were as observed. The TTA recorded in watermelon medium was between 0.444-0.636%, the watermelon-banana mixture medium had a TTA range of between 0.656-0.901% while watermelon-pineapple mixture was between 0.707-0.924% (Fig. -4).

The alcohol content (%) in the mixed cultures fermentation medium of watermelon was having no record of alcohol yield until the 2nd day of fermentation where 0.4% was recorded and thereafter it increased gradually even till termination of experiment when 1.12% was recorded. In the watermelon-banana mixture medium, it was initially 2.4% after 24 hours of fermentation and 4.08% at end of fermentation. Also in the watermelon-pineapple medium, alcohol volume of 2.8% was recorded after 24 hours of fermentation and gradually, increased in the medium to 5% at termination of fermentation. (Fig. -5). In the monoculture fermentation, the watermelon medium yielded alcohol content of 1.2% after 24 hours of fermentation and increased to 2.6% at termination of experiment. Watermelon-banana mixture also yielded alcohol content of 0.65% which also increased to 5.11% at the end of fermentation and watermelon-pineapple medium had alcohol yield of 0.10% which as well increased to 6.26% at the fifth day of fermentation (Fig. -6).

Sensory evaluation

The mean scores obtained from the analysis of variance (ANOVA) from each of the characters tested in the sensory evaluation of samples is shown in Table -1. Means followed by the same letter within each column are not significantly different at ($p \leq 0.05$). there were significant differences ($p \leq 0.05$) in the colour, taste, aroma and overall acceptability of the wine samples. Watermelon - pineapple wines produced from the mixed and monoculture fermentation were the most favoured in colour, taste aroma and overall acceptability followed by watermelon-banana wine and was least in watermelon wine.

DISCUSSION

Alcoholic fermentation of the tropical fruits in single and mixed forms were controlled by limiting days of fermentation so that the alcohol yield during fermentation will not be oxidized to acetalde and acetic acid by acetic acid bacteria. Alcohol was not record in the media after 24 hours of fermentation and could be due to the presence of *K. apiculata* and *T. delbruckii* which were predominant yeast recorded in the medium at the initial stage. These yeast species were only predominant because there was no high yield of alcohol in the media. And this is in conformity with Reed and Talik (1991) who reported that fermentation of 'must' is initiated by weekly fermenting yeast and were replaced latter by more alcohol tolerant yeast. After 24 hours of fermentation, *S cerevisiae* started increasing in cell mass and increase in alcohol content was observed along side. During this stage in the fermenting media, sweet odour was emitted which could be as a result of breaking down of some elements by microorganisms and are released in the fermenting media to give the wine a characteristic change in term of alcohol and other compounds. This observation collaborates with Soles, *et al.,* (1982) who reported that due to the metabolism of yeast during fermentation, a variety of compounds beside ethanol are produced and Herraiz, *et al*., (1990) who reported that the products of yeast during fermentation are released into the fermenting medium and contributes to wine flavor, so that wine quality is on the kind of compounds and concentrations at which the compounds are produced.

Generally in the fermenting media, a drop in pH was observed through the period of fermentation. It was noticed that the more drop in pH the higher the titrable acidity and the higher the alcohol yield. The decrease in pH values suggests that fermentable sugars are being fermented by lactic acid bacteria which indeed were responsible for the alcohol yield to the amount of lactic acid present in the media. In most cases particularly, the first day of fermentation, it was seen that alcohol was absent in both the mixed and monoculture fermentation thereby giving room for the higher pH and the lowest TTA (%) recorded in the various media. If the pH were not to be reduced in the medium, the growth of spoilage microorganisms would have been encouraged as Sponholz (1993) reported that juices and wines of high pH (e.g 4.0) have been spoilt by the growth of *Clostridium butyricum* and have elevated concentration of butyric acids, isobutyric acid, propionic acid and acetic acid.

It must be understood that for a juice to become wine, fermentation must occur by degrading the fermentable sugars to lactic acid by yeast species and lactic acid bacteria. This condition in the media was however responsible for the gradual drop in pH, the gradual increase in TTA and the gradual increase in alcohol yield.

Sensory evaluation of the wine samples showed that wines produced from mixtures of fruits were rated best in colour, taste aroma and overall acceptability. This could be due to the combined fruits concentration which incredibly reflected as examined in the characteristic qualities of the fruit wines.

Conclusion

The wines produced from fruit mixtures were found to be of better quality than the single fruit wine. Also the monoculture fermented wine yielded more alcohol than the mixed culture due to higher yeast counts recorded during fermentation. Monoculture fermented wine gives a better characteristic quality than mixed culture fermented wine. This work suggests that similar tropical fruits could be used for the production of a quality wine with probable economic benefits to producers and also will limit the consumption of whole available sugars present in fruits to reduce any harmful effect of excess sugar intake in fruits.

REFERENCES

1. Boulton, R.B; Singleton, V.C; Bisson, L.F; and Kunkee,R.E. Principles and practices of wine making (3rd ed) Chapman and Hall. New York. 231-236 (1995)

2. Davis, C. Bioreactor technology and wine fermentation. In G.H. Fleet (ed), Harwood Academic Publishers, Chur, Switzerland. 449-475 (1993)

3. Doyle, P. M. Food Microbiology Fundamentals and Frontiers. America Society for Microbiology edited by Doyle, P. M; Benchat, L.R and Montville, T.I. 671-694 (1997)

4. FIIRO, Federal Institute of Industrial Research, *Oshodi, Newsletter* **15(19):** 3-5 (1989)

5. Herraiz, T; Herraiz, M; Reglero, G; Martin-Alvarez, P.J and Cabezudo, M.D. Changes in the composition of fatty acid during the alcoholic fermentation of grape 'must'. *Chemistry of Microbial Technology*. **12**. 185-188 (1990)

6. Ihekoronye, A.L and Ngoddy, P.O. Integrated food Science and Technology for the tropics. Macmillan Publishers, Hong-Kong. 386 (1985)

7. Reed, G. and Talic, W.N. Yeast Technology; Library of congress cataloging 2nd ed. in publication data. 151 (1991)

8. Shreier, P. Flavour composition of wine: *A review. CRC Crit Rev Food Science and Nutrition* 12:59-111 (1979)

9. Sole, R.M, Ouch, C.S and Kunkee, R .E. Ester concentration difference in wine fermented by various species and strains of yeast. *America Journal of Ernol Viticulture*. **33:** 94-98 (1982)

10. Sponholz, W. G. Wine spoilage by microorganism. In A.H. Ross and J. S. Hanson (ed), Academic Press, London. 395-420 (1993)

11. Yamaguchi, M. World Vegetables. Principal production and nutritive value. Ellis Harwood Limited publishers Chichester, England. 327-329 (1983)