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Full Length Research Paper

Novel method of wine production from banana (*Musa acuminata*) and pineapple (*Ananas comosus*) wastes

Isitua, C. C.* and Ibeh, I. N.

Department of Microbiology, University of Benin, Benin City, Nigeria.

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Wine production from banana and pineapple wastes (*Musa acuminata* and *Ananas comosus*) was carried out by controlled fermentation for 5 days. Fermentation of these wastes was done in groups: Group 1 and 3 (test and control group for banana wastes) and group 2 and 4 (test and control group for pineapple wastes). Pumpkin leaves (*Telfaria occidentalis*) macerate was added to group 1 and 2 to obtain substrate : leaves : water ratio of 1.5:0.02:3.0 (kg w/v). The mixture was boiled after 18 h at 100°C for 30 min and the filtrates obtained (1.8 ± 0.2 L) was inoculated with 1.0 ml of x 10^9 cfu/ml of *Saccharomyces cerevisiae* var. ellipsoides and left at room temperature (28 ± 1.0°C) for 5 days. During the fermentation period, the pH, specific gravity, temperature, percentage of alcohol content and acidity value were monitored. The microbial population in banana waste, pineapple waste and pumpkin leaves was also determined. Wine produced from substrates treated with pumpkin leaves had higher alcoholic content (0.57%) than the untreated controls (0.035 - 0.21%). The bacterial isolates from pumpkin leaves were *Erwinia* sp., *Serratia* sp., *Micrococcus* sp., *Bacillus* sp. and *Staphylococcus epidermidis*, while the fungal isolates were *Rhizopus* sp. and yeast.

Key words: Fermentation, banana, pineapple, wine.

INTRODUCTION

Fermentation of food for preservation, enhancement of nutritive values, improvement of flavor and preparation of beverages has been practiced probably since prehistoric times by people of nearly every civilization (Okafor, 2007; Sofos, 1993).

In recent times, home wine production has been practiced with various fruits such as apple, pear and strawberry, cherries, plum, pineapple and oranges (Fleet, 1993; Webb, 1984). Wine are healthful beverages that has been seen as a natural remedy for man's illness from early days and are said to aid recovery during convalescent period (Jay, 1996; Okafor, 2007). Fermentation processes are usually done by species of the yeast *Saccharomyces*, whereby the sugars in the fruit juice are converted into alcohol and organic acid, that later react to form aldehydes, esters and other chemical components (Watanabe and Shimazu, 1980).

Fermentation could either be spontaneous, by natural flora of the fruit or controlled by introducing industrial strain of yeast to ferment the juice. Nowadays, the Nigeria people establish large plantations of banana and pineapple which are used mainly in the industries for the production of pineapple and banana juice and for home consumption. A considerable part of these fruits is wasted during these processes. With the present government's policy on agriculture, more plantations are envisaged in the near future and this invariably means producing lots of banana and pineapple wastes.

The present study was intended to determine the potential of the waste of ripe banana and pineapple fruits for wine production. The outcome of this study may expand the utility of banana and pineapple wastes. That would not only ensure a cleaner environment but also create more job opportunities, reduce seasonal losses of the fruits and serve as a substitute for imported wines by increasing the production of home beverages.

MATERIALS AND METHODS

Sample collection

Mature ripe banana (*Musa acuminata*) and pineapple (*Ananas*

*Corresponding author. E-mail: christykings@yahoo.com.

Table 1. Changes in the fermentation parameters of banana waste wine.

Parameter	Group	
	1	3
pH	5.18	5.70
Specific gravity	1.00	1.05
Percentage of alcohol	0.57	0.035
Temperature (°C)	26	26
Acidity value	2.20	3.03

Table 2. Changes in the fermentation parameters of pineapple waste wine.

Parameters	Groups	
	2	4
pH	4.76	5.16
Specific gravity	1.00	1.05
Percentage of alcohol	0.57	0.21
Temperature (°C)	26	26
Acidity value	8.26	10.56

comosus) fruits together with pumpkin leaves (*Telfaria occidentalis*) were purchased from a local market in Benin City, Nigeria. Culture of *Saccharomyces cerevisiae* Var. ellipsoides (yeast) obtained from Bendel Breweries PLC, Benin City, Nigeria was maintained on saboraud dextrose agar slants and stored at 4°C. This yeast was used for pitching.

Fermentation process

A total of 4 fermentation protocols were set up based on the substrate and controlled fermentation was carried out in 12 L fermentation vessels for 5 days. The groups are: Group 1 and 3 (test and control for banana waste) and group 2 and 4 (test and control for pineapple waste).

Ripe banana and pineapple fruits were washed with distilled water, their skin were peeled and separated from the pulp. 1.5 kg each of the wastes generated was macerated using a sterile mortar and pestle and each macerate was deposited in their respective pots (group 1 to 4). 0.02 kg each of pumpkin leaves macerate were added to the test group (groups 1 and 2) only and portions of it were cultured in nutrient agar, Mac conkey agar and potato dextrose agar for the isolation of heterotrophic bacteria and fungi, respectively. Three litres of distilled water was added to the various macerate in the set up fermentation protocols. They were covered and allowed to stand for 18 h. Thereafter, the mixtures of the various protocols were boiled using a bunsen flame at 100°C for 30 min. The mixture was cooled to ambient temperature and filtrate (fermentation broth) was obtained by sieving into the fermentation vessel. The whole broth was vigorously shaken for proper mixing and aeration before pitching with 1.0×10^9 cfu/ml of yeast.

The temperature, pH, specific gravity, acidity value and alcohol content were monitored daily throughout the course of fermentation and the fermentation vessels were vigorously shaken before sampling. At the end of the fermentation, the wine produced were run off into clean sterile bottles, tightly closed and left to stand. The wine was pasteurized at 65°C for 30 min, cooled and racked.

Microbial analysis

Microbial analysis of each fermentation broth was performed for 48 h in pour plate method using nutrient agar, Mac Conkey agar and potato dextrose agar. The nutrient agar used was treated with fulcin to suppress fungal growth. From the culture plates prepared, distinct colonies were picked for characterization and identification with the aid of Bergey's Manual of Determinative Bacteriology (Holt et al., 1994). Moulds were identified with reference to the method described by Barnett et al. (2000).

Fermentation analysis

The following parameters were analyzed day by day during the course of fermentation: pH (determined with Jenway 3030 pH meter, Kent Electronic Instrument, England), temperature (determined with mercury thermometer), specific gravity (determined using the specific gravity bottle method), alcohol content and acidity value (determined with reference to the method of AOAC International, 2003).

RESULTS AND DISCUSSION

Wine were successfully developed using the waste of banana and pineapple fruits. The effect of pumpkin leaves infusion increased alcohol content of wine produced after fermentation from 0.035 to 0.57% and 0.21 to 0.57% for banana and pineapple waste wine, respectively (Tables 1 and 2). There were changes in pH, acidity value and specific gravity of the fermentation broths (Tables 1 and 2). Microorganisms isolated from the fermentor and pumpkin leaves adjunct were *Alcaligenes* sp., *Citrobacter* sp., *Acinetobacter* sp., *Erwinia* sp., *Rhizopus* sp., *Mucor* sp., *Leuconostoc* sp., *Micrococcus* sp., *Serratia* sp., *Bacillus* sp. and *Staphylococcus epidermidis* (Tables 3 and 4).

The present study was carried out in a small scale. Wine was prepared from banana and pineapple waste using pumpkin leaves adjunct as facilitator in order to determine whether it would lead to the production of wine with better characteristics. Wine preparation from banana and pineapple waste was considered a bioconversion method that can facilitate easy removal of these wastes from the environment. The application of banana and pineapple waste into wine production may provide alternatives to the already established wine production raw materials such as grapes and vines. Similar considerations have led to the tentative application of pineapple wastes in alcohol production and wine production from over-ripe banana (Etuk, 1997; Fleet, 1993).

At the beginning of the experiment, the microorganisms associated with pineapple and banana peels as well as pumpkin leaves infusion were determined by culturing samples of these three items in appropriate growth media. Ten microorganisms comprising 8 bacteria and 2 fungi were recovered from pineapple peels infusion and 9 microorganisms comprising 7 bacteria and 2 fungi from banana peels infusion (Table 3). The pumpkin leaves infusion yielded 7 microorganisms comprising 5 bacteria

Table 3. Microbial isolates from banana and pineapple waste wine

Microorganism	Source	
	Banana waste	Pineapple waste
Alcaligenes sp.	+	+
Citrobacter sp.	+	+
Acinetobacter sp.	-	+
Lactobacillus sp.	-	+
Erwinia sp.	+	+
Serratia sp.	+	+
Leuconostoc sp.	+	-
Micrococcus sp.	+	+
Bacillus sp.	+	+
Rhizopus sp.	+	+
Mucor sp.	+	+

+, Presence; -, absence.

Table 4. Microbial isolates from pumpkin leaves.

Organism	Isolate
Bacteria	*Erwinia* sp., *Serratia* sp., *Micrococcus* sp., *Bacillus* sp., *Staphylococcus epidermidis*.
Mould	*Rhizopus* sp., yeast.

and 2 fungi (Table 4). The microorganisms isolated in this study have largely been associated with materials from which they were recovered (Igue, 1995; Prescott et al., 2008).

During fermentation, there were no temperature changes in the fermentation group. The pH of the fermentation media showed wider variation than the control, group 3 and 4 (Tables 1 and 2). This may be due to increased microbial activities which led to more acid production. Slight changes in the specific gravity of the fermentation broth were observed and these changes did not show any significant difference ($P > 0.01$) between the controls and the ameliorated fermentation broth. Group 4 fermentation broth yielded the highest acidity value and this increase may be associated with an increase in microbial population and their metabolites in the medium. This finding is similar to the observations of Igue (1995).

The fermentation process yielded wine with different alcoholic content. The difference in alcoholic content may be due to difference in amount of fermentable sugars in the raw materials and perhaps difference in the availability of the sugars for bioconversion by the fermenting yeast. Wine from banana waste without any treatment other than controlled fermentation had alcoholic content of 0.035% (w/v), while pineapple waste yielded wine with alcoholic content of 0.21% (w/v). This finding suggests that pineapple waste had more sugar content than the banana waste. This result agrees with the report of Igue (1995) which showed that pineapple waste contains almost twice as much sugar as plantain peels.

Treatment of banana and pineapple waste with pumpkin leaves infusion increased the alcoholic content of wines produced significantly ($p < 0.05$) when compared with the control. The pumpkin leaves contained many pectinolytic organisms such as *Erwinia* sp., *Serratia* sp. and *Bacillus* sp. which may have acted on the banana and pineapple waste to release free fermentable sugars, hence, the increase in the alcoholic content of wine produced. This view agrees with the established potential of pectinolytic organisms (Prescott et al., 2008).

Conclusion

Wines were produced using banana and pineapple waste. Therefore, wine production can be done with the utilization of the banana and pineapple waste which is currently viewed as a waste that is normally discarded. Treatment of substrates for wine production with pumpkin leaves infusion increased alcoholic content of wine produced after fermentation from 0.035 to 0.57% and 0.21 to 0.57% for banana and pineapple waste wine, respectively. Therefore, this material may provide good adjuncts for wine and alcohol production.

There is therefore the need for further studies on the potentials of pumpkin leaves infusion in wine production from cellulolytic or pectinolytic materials.

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