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OPTIMIZATION OF THE STERILIZATIONTEMPERATURE AND TIME FOR PALM WINE PRESERVATION

Aniaku, Vincent Oluchukwu, Department of Applied Microbiology and Brewing, Enugu State University of Science and Technology Enugu, Nigeria

Abstract: *Studies were carried out to establish the optimum temperature and time for sterilization of palm wine to enhance its shelf life.In the studies, the temperature and time of sterilization of the beverage were varied within the range of 40-75^{o}C and 10/20 minutes in order to establish the optimum time and temperature for its sterilization without affecting the beverage's quality in terms of the taste and aroma profile.Each 500ml of palm wine sample was respectively heat-treated at the respective temperatures for 10 and 20 minutes. The result of the studies showed that bacteria and yeast load decreased with the increase in temperature and time of sterilization. The taste and aroma profile diminished with the increase in temperature and time of sterilization. The temperature and the time at which there was complete destruction of organism with retention in taste and aroma of the beverage was 65^{0}C and 10 minutes respectively. A Plot of the number of surviving cells against the temperature of sterilization at a given time follows a log linear kinetics. The statistical evaluation of the sample sterilized at 65^{0}C for 10 minutes when compared with the fresh untreated sample (control) showed no significant different between the samples at 95% confidence level.*

Keywords: *Palm wine, Optimization, Sterilization temperature and time, Bacteria, yeast, Aroma and Taste*

INTRODUCTION

Palm wine is a traditional alcoholic beverage popularly drunk in tropical countries of the world, including Nigeria. It is highly valued among the Igbos in the south Eastern part of Nigeria as the best alcoholic, especially for traditional ceremonies. It is sourced from the sap of male inflorescence (*Elaeisguineensis*). The sap which is rich in sugar is fermented naturally by yeasts of the genera, *Saccharomyces*. Lactic acid bacteria have been implicated to contribute to the characteristic aroma of fresh palm wine (Okafor, 2007). The sources of the yeasts and bacteria microflorae include the air, knife and the palm wine keg used by the tapper in harvesting the sap. The sap undergoes spontaneous fermentation which promotes

the proliferation of microorganisms for the conversion of the sweet substrate into several metabolites which include: alcohol, lactic acid and acetic acid. The alcoholic content of the freshly harvested palm wine is about 3.0%. The alcoholic content increases with time due the fermentative activity of the yeasts. The major problem associated with the handling of the beverage is its short shelf life, due to the uncontrolled metabolic activity of the yeasts and bacteria **(**Chandrasekhar *et al*. 2012**).** Several attempts to preserve the beverage using chemical, ultraviolet and heat treatments have met with little success. (Eshie,2001**).** The generally accepted view is that thermal death is a first order process, which means that at any given temperature and time, the rate of death depends upon the number of viable cells present (Adams and Moss, 1995). The establishment of the optimum temperature at which the beverage will be sterile and still retains its aroma and taste would be a most welcome development.

METHODOLOGY

Sterilization

Each 500ml sample of fresh palm wine, stored in a sterile 500ml glass bottle, was heat-treated at respective temperatures of 40^0C, 45^0C, 50^0C, 55^0C, 60^0C, 65^0C, 70^0C and75^0C for 10 and 20 minutes in a thermostatically controlled water bath. The samples were cooled and cultured for bacteria and yeast using nutrient agar and sabourand dextrose agar respectively to determine the effectiveness of the heat sterilization.

Shelf stability test

The heat-treated samples were cooled to 30^0C and stored at room temperature for one month, after which they were cultured for the growth of bacteria and yeast. The bacteria and yeast count of the surviving organisms in the sample heat-treated at different temperatures were determined using serially diluted samples.

Bacteria cultures were gram-stained and microscopically examined using oil immersion (×100) objective lens. The yeast cultures were stained using lactophenol cotton blue solution and examined under and (×40)

Organoplaetic analysis of treated and untreated (whole) palm wine samples

Sensory evaluation of the palm wine samples heated-treated at different temperatures and time and of the control (whole, fresh palm wine sample) was carried out using scoring and grading methods. The sensory attributes evaluated were taste and aroma.

RESULTS AND DISCUSSION

Table 1: Palm Wire Samples Treated For 10 Minutes

Sample	Bacteria count (CFU/ml)	Yeast count (CFU/ml)	Taste and aroma profile
Control			
40^0C	1.5×10^4	2.0×10^4	Off-taste /aroma
45^0C	1.2×10^4	1.8×10^4	Off-taste /aroma
50^0C	1.0×10^3	1.3×10^4	Off-taste /aroma
55^0C	1.0×10^2	1.0×10^2	Off-taste /aroma
60^0C	Nil	1.0×10^2	Off-taste /aroma
65^0C	Nil	Nil	Taste and aroma intact
70^0C	Nil	Nil	Retention of taste but loss of aroma
75^0C	Nil	Nil	Retention of taste but loss of aroma
80^0C	Nil	Nil	Retention of taste but loss of aroma

The results of the bacteria and yeast count analysis showed that the population of surviving cells decreased with the increase in temperature and time of sterilization. The sample sterilized at 65^0C for 10 minutes was found to have zero count of bacteria and yeast while retaining taste and aroma. The samples heat-treated at 70^0Cand 75^0C, though sterile were found to have retained the taste but lost the aroma of the beverage. The decline in the number of both bacteria and yeast with the increase in temperature agreed with the findings of Adam and moss (1996) that thermal death is first order process which implies that the rate of death depend on the number of viable cells present. The plot of the number of surviving cells at a given temperature and time showed a downward slope.

Table 2: Palm Wine Samples heat-treated for 20 Minutes

Sample	Bacteria count (CFU/ml)	Yeast count (CFU/ml)	Taste and aroma profile
Control			
40^0C	1.2×10^4	1.6×10^4	Off-taste /aroma
45^0C	8.0×10^2	1.4×10^4	Off-taste /aroma
50^0C	5.0×10^2	1.0×10^3	Off-taste /aroma
55^0C	1.0×10^2	6.0×10^2	Off-taste /aroma
60^0C	Nil	1.0×10^2	Off-taste /aroma
65^0C	Nil	Nil	Taste and aroma intact
70^0C	Nil	Nil	Retention of taste but loss of aroma
75^0C	Nil	Nil	Retention of taste but loss of aroma
80^0C	Nil	Nil	Retention of taste but loss of aroma

Table 2 shows that heat treatment for 20 minutes reduced the cell number of bacteria and yeast but impaired the aroma of palm wine samples at temperature above 65^0C.

The analysis of variance of the values obtained on the taste and aroma evaluation of the sample heat- treated at 65^0C and the control shows no significant ($P < 0.05$) difference. The samples sterilized within the temperature range of 45^0C to 60^0C were characterized by off-taste and aroma, while samples sterilized above 65^0C up to 75^0C retained their sweet taste but lost the characteristic aroma of palm wine. These findings implied that between 40^0C and 60^0C, some bacteria and yeasts survived the heat sterilization and metabolized the sugars and the macromolecules to alcohol and off- flavor compounds. The retention of taste in the samples sterilized above 65^0C can be attributed to the total extinction of microbial life. The loss of aroma of the sample heat-treated above 65^0C for 20 minutes could be due to the volatility of the flavor compounds especially the esters at high temperatures.

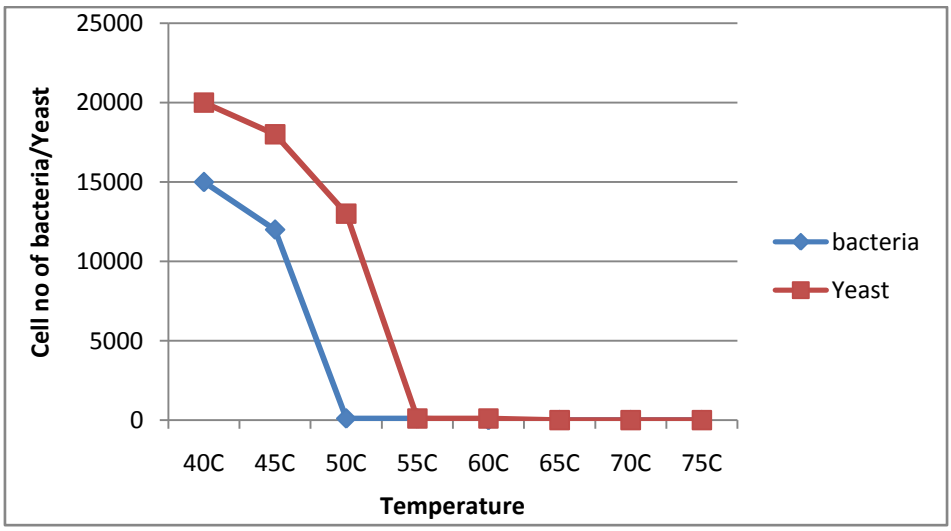

Fig 1: Effect of sterilization temperature on cell number of bacteria /yeast in palm wine treated for 10 minutes

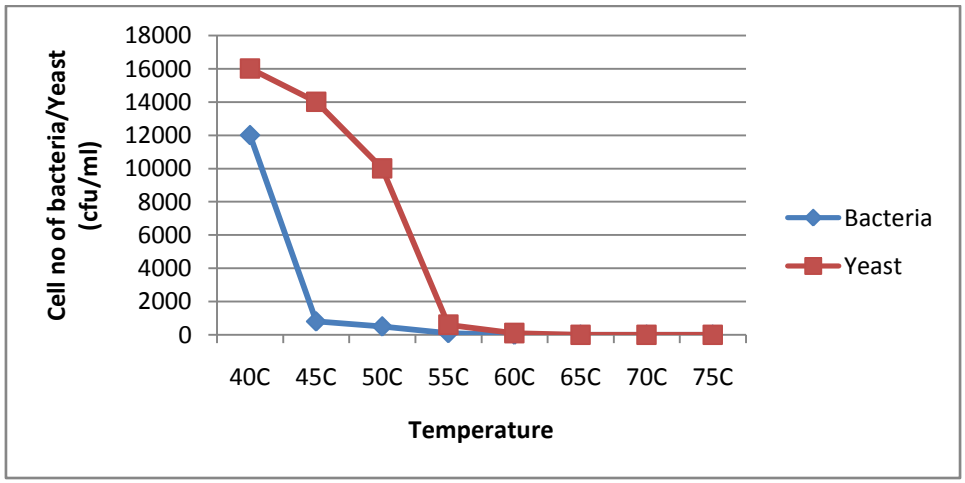

Fig 2: Effect of sterilization temperature on cell number of bacteria/yeast in palm wine treated for 20 minutes

CONCLUSION AND RECOMMENDATION

The results of the study have shown that the optimum sterilizing condition is 65^0C for a period of 10 minutes to enhance the shelf stability of the beverage with special reference to taste and aroma. Heat sterilization is preferred to the use of chemical preservatives as there is no side effect associated with heat treatment.

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