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Effect of heat and addition of sugar on pineapple must fermentation

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ABSTRACT

Pineapple, a tropical fruit with an important sugar content, is often used to produce a traditional wine. This study was carried out to explore the effect of heat and addition of sugar on pineapple must fermentation. Pineapple must was fermented and total soluble solids content, pH, temperature and alcohol content were analysed. A significant decrease in total soluble solids was detected during the fermentation (21.83 ± 0.34 to 7.00 ± 0.37), the pH value between 4.19 ± 0.02 and 3.39 ± 0.03 and the fluctuation in temperature was observed during the fermentation. The alcohol content significantly increased in all samples during fermentation. The alcohol content also significantly increased in the presence of sugar (9 ± 0.2 after 24 hours and 10 ± 0.2 after 48 hours) respectively. The use of yeast and sugar might be an important option to improve the alcohol content in pineapple wine. It will be important to explore the chemical component in both spontaneous and yeast fermentation for defining the quality of the traditional pineapple wine.

Keywords: Wine, Pineapple, Fermentation, Sugar, Yeast.

INTRODUCTION

Pineapple (*Ananas comosus*), from the Bromeliaceae family, is one of the most popular fruits cultivated in tropical and sub-tropical regions. Pineapple, the third most important tropical fruit in the world after banana and citrus is a perishable fruit with exceptional juiciness and has a particular tropical flavor and health benefits (Debnath et al., 2012). Pineapple fruit contains water, carbohydrates, sugars, vitamins A, C, carotenes, refreshing sugar-acid balance and organic acids (Brat et al., 2004). An important part of the pineapple produced is consumed as fresh fruit in the cultivated country (Loeillet, 2005). However, pineapple is largely consumed around the world as canned pineapple slices, chunk and dice, pineapple juice, fruit salads, sugar syrup, alcohol, citric acid, pineapple chips and pineapple puree (Chaudhary et al., 2019). Besides its nutritional and medicinal assets, pineapple plays an important role in the economy of farmers and food industries (Rohrbach and

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D'Eeckenbrugge, 2003). Therefore, the production of pineapple is an important activity for farmers in different countries. However, Togo is not neither in the first group of pineapple producing states nor in the second group, the production of pineapple is becoming more dynamic in Togo due to its assets. This increase in pineapple production in Togo has stimulated different actors like transformation and exportation during the last years (Anani et al., 2020). In fact, it was reported that the exportation of pineapple contributed 0.42 million USD to Togo gross domestic product (GDP) (GIZ/ProDRA, 2017). The production of pineapple in Togo is still progressing and the annual production was about 30,000 tons produced by 3200 farmers in 2019 (GIZ et UE, 2019). Considering the perishability of this fruit, it is necessary to explore different technics that can help to avoid loses if the production resulted to be more than the direct consumption and exportation request. The transformation of local raw material is very important to generate job and to boost the incomes of the populace. Therefore, the aim of this study was to investigate the effect of heat and addition of sugar on pineapple must fermentation.

MATERIALS AND METHODS

Plant material

Full-ripened pineapple fruits (*Ananas comosus*, Cayenne lisse) were bought from the local farmers in Gbatopé (Tsévié, Togo). Pineapple was selected for uniformity size and color and stored at room temperature. Yeast was purchased from the local market.

The pineapples were washed with clean water then peeled and grinded to obtain the must. The must was divided into different samples. One sample was immediately transferred into a transparent plastic bottle for spontaneous fermentation (SF), while the other sample which contained sugar was also transferred into the bottle for spontaneous fermentation (SSF). A part of chaptalized must was transferred into another bottle which contained yeast for fermentation (SYF). One sample was treated at 60°C for 15 minutes before transferring it into a transparent plastic bottle which contained yeast for fermentation (TYF). A part of treated must was chaptalized before putting into the bottle which contained yeast for fermentation (TSYF). The chaptalization of the must was done with 100 g of white sugar for 1000 g of pineapple must. The fermentation process was done under control during two days.

Total soluble solids content

The total soluble solids content, expressed as °Brix, of pineapple must samples was measured with an optical hand-held refractometer. Some drops of the sample were placed on the prism of the refractometer using a pipette. On closing the folding lid, the sample was evenly distributed between lid and prism. The value was read off between the light / dark boundaries. At least three measures were obtained by sample and by production.

pH measurement

The pH of all pineapple must was measured at 25°C (HANNA HI98128, Woonsocket, Rhode Island, USA). The pH meter was calibrated with two buffer solutions (pH 7 and pH 4). At least five measurements were obtained for each pineapple must.

Temperature

The temperature of each must was measured during the fermentation with a hand-held thermometer which was introduced into the bottle. At least three measures were obtained by sample and by production.

Alcohol content

The alcohol content was determined by the method of alcoholometry after a distillation. In a 100 ml vial, the wine was filled up to the gauge mark. Heating was carried out using a tank heater, and the vial was connected to a refrigerant. As soon as the wine began to boil, the rising vapor was cooled by water and it came out as a liquid. The recovered distillate was transferred to a graduated cylinder which was filled with distilled water and the alcohol content was assessed by an alcoholmeter.

Statistical analysis

Significant differences ($p \leq 0.05$) among different samples were assessed by one-way-analysis of variance (ANOVA) with a Tukey and LSD post-hoc test. An SPSS software was used for statistical analysis (Version 29.0.1.0, IBM SPSS Statistics, Armonk, New York, USA).

RESULTS

Total soluble solids content, pH and temperature

The total soluble solids (TSS), expressed as Brix degree, of pineapple must was reported in Figure 1. It was observed that the chaptalized samples had a high TSS value (≈ 21.8 °Brix) than samples without sugar (≈ 16 °Brix) at the beginning, as expected. The total soluble solids significantly decreased in all samples during the first 24 hours of fermentation. However, it was evident that the decrease in TSS content was significantly high in samples which contained yeast than in samples where we observed a spontaneous fermentation.

The pH of the pineapple must was shown in Table 1, and it revealed to be significantly high in heated sample (4.19 ± 0.02) than in unheated samples (3.68 ± 0.06), but ranged into the interval value of tropical fruit pH (Akubor et al., 2003; Dioha et al., 2009; Sahu et al., 2012; Ray et al., 2012; Ogodo et al., 2015). The pH significantly decreased in all samples after the first 24 hours of fermentation.

The temperature of the pineapple must was reported in Table 1, where we observed that the initial temperature was around 30 °C in all products. Fluctuations in temperature of the must were observed during the period of fermentation.

The alcohol content

The alcohol content of different pineapple wine was shown in Figure 2. The treated sugar yeast fermentation (TSYF) and sugar yeast fermentation (SYF) samples showed the highest alcohol content (9.0 ± 0.2% g alcohol / 100 g of product) after 24 hours, followed by treated yeast fermentation sample (5.0 ± 0.2%). The spontaneous fermentation (SF) and sugar spontaneous fermentation (SSF) samples showed the lowest alcohol content but both had the similar alcohol content (2.0 ± 0.2%). The alcohol content significantly increased in all samples after 48 hours of fermentation (Ogodo et al., 2015) except in SF sample where the alcohol content resulted to be similar after 48 hours of fermentation. In the case of the sample which contained sugar (SSF), sample showed an increase of alcohol content after 48 hours of fermentation. The heated sample with yeast fermentation (TYF) exhibited a significant high alcohol content, 5% and 6% for 24 and 48 hours respectively, as compared to SF, 2% after 24 and 48 hours.

Table 1: pH and temperature of different samples during the fermentation. Different letters near the value indicate significant difference at different times ($p \leq 0.05$), where "a" letter was assigned to the highest value.

Hours	**0**	**24**	**48**
Samples		pH	
SF	3.68 ± 0.02 (a)	3.55 ± 0.03 (b)	3.55 ± 0.01 (b)
SSF	3.68 ± 0.06 (a)	3.52 ± 0.02 (b)	3.39 ± 0.03 (c)

TYF	4.19 ± 0.04 (a)	4.10 ± 0.04(b)	4.03 ± 0.06 (c)
SYF	3.68 ± 0.06 (a)	3.60 ± 0.05 (b)	3.52 ± 0.02 (b)
TSYF	4.19 ± 0.02 (a)	4.04 ± 0.04 (b)	3.85 ± 0.025 (c)
		Temperature	
SF	30.53 ± 0.03 (b)	33.06 ± 0.04 (a)	33.45 ± 0.13 (a)
SSF	30.70 ± 0.02 (c)	32.53 ± 0.22 (b)	33.45 ± 0.19 (a)
TYF	31.26 ± 0.02 (b)	34.25 ± 0.02 (a)	38.94 ± 0.03 (a)
SYF	31.65 ± 0.13 (c)	34.45 ± 0.13 (b)	34.30 ± 0.02 (a)
TSYF	31.00 ± 0.01(c)	35.33 ± 0.10 (b)	38.51 ± 0.06 (a)

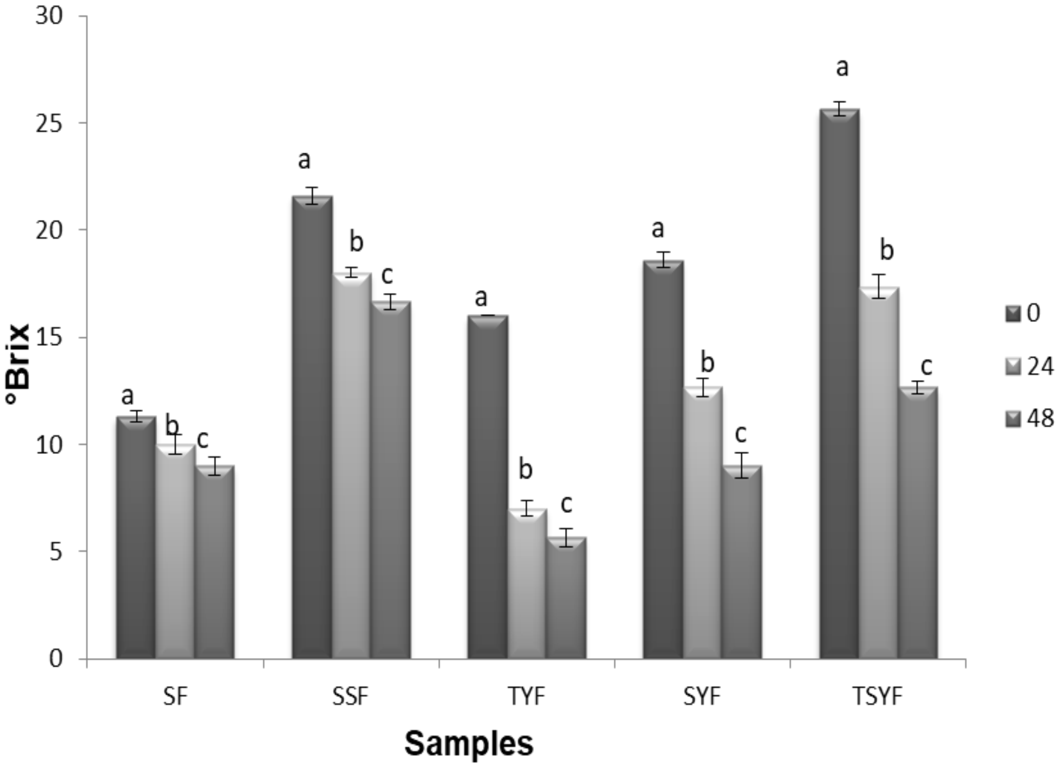

Figure 1: Total soluble solids during the fermentation. Different letters on the figure indicate significant difference among samples (p ≤ 0.05), where "a" letter was assigned to the highest value.

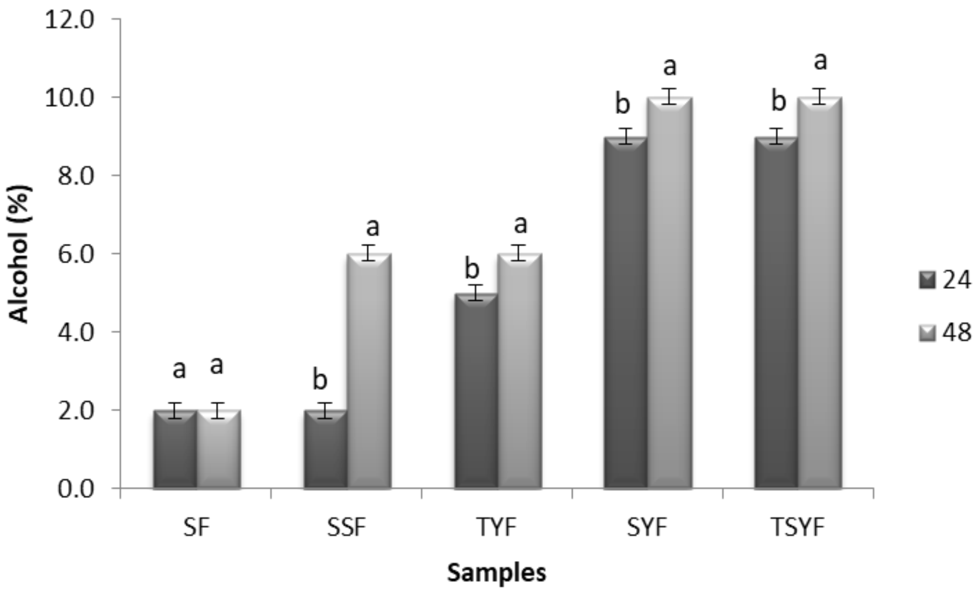

Figure 2: Alcohol content during the fermentation. Different letters on the figure indicate significant difference among samples ($p \leq 0.05$), where "a" letter was assigned to the highest value.

DISCUSSION

The decrease of TSS in different samples might be associated to the fact that sugar was converted into alcohol by endogenous microorganism or yeast. The evident decrease of TSS in samples with yeast might be explained by the fact that the yeast had the highest ability to convert sugar than endogenous microorganism. The decrease of TSS content was also reported by different studies about fruit wine production (Mohanty et al., 2006; Panda et al., 2014a, b).

The increase of pH in heated sample was also observed by other authors and they associated it to the possible biochemical reactions which occurred during the heating (Chadare et al., 2021). The decrease of pH during fermentation might suggest that organic acids, in particular acetic acid, were produced (Ogodo et al., 2015; Umeh et al., 2015) and it revealed that the pineapple wine might be relative acid (Diakabana et al., 2014). The low pH is favourable to the growth of the fermenting yeast than the endogenous microorganism (Reddy & Reddy, 2005). More so, the decrease of the pH during fermentation plays an important role as protecting the wine from the spoilage microorganism (Musyimi et al., 2024).

The Fluctuations in temperature of the must during the period of fermentation could be associated to the growing of the fermenting microorganism (Ogodo et al., 2015; Thapa & Tamang, 2006) and to the various biochemical changes (Shittu et al., 2019).

The similar alcohol content in SF at 24 and 48 hours might be associated to the fact that the endogenous microorganism, which are responsible for the spontaneous fermentation, had a low capacity to transform all pineapple sugar into alcohol. However, the increase of alcohol content in SSF samples after 48 hours might suggest that the composition of pineapple sugar had an important role on fermentation. This is, because the endogenous microorganism could better transform sucrose to alcohol compare to the pineapple sugar (Isitua and Ibeta, 2010). Addition of sugar might provide a suitable condition for the growth of the endogenous microorganism (Balamaze and Wambeti, 2017). The high alcohol content in heated sample with yeast fermentation might be associated to the limited competition with endogenous microorganisms which were probably destroyed by the heating. In fact, it was reported that the characteristics of the fermented product are related to the yeast strain, the performance of the yeast to transform sugar into alcohol and composition of different fruits (Fleet, 2003; Duarte et al., 2010; Chilaka et al., 2010). The combination of heating and the yeast fermentation allowed to produce pineapple wine with an alcohol content around 5% and 6% after 24 and 48 hours respectively without adding sugar. It was reported that the alcohol content in wine obtained from mango ranged between 6.40 and 7.5% (Ogodo et al., 2018). This result confirmed that the endogenous microorganisms are not able to convert all pineapple sugar into alcohol. This might be associated to the heterogeneous of the endogenous microorganism, their competition in the use of the pineapple sugar and their secondary metabolites inhibition on each other, respectively. However, samples with the addition of sugar showed the highest alcohol content, as observed in cane wine (Lepengue et al., 2020), that value did not show significant difference in treated and untreated samples. This might suggest that in the presence of sugar, the yeasts grow quickly and inhibiting the endogenous microorganism. Addition of sugar aThe presence of added sugar

Conclusion

The present study investigated the effect of heat and addition of sugar on the pineapple must fermentation and showed that pineapple can be used to produce a wine with acceptable alcohol content without added sugar but by using Saccharomyces cerevisiae. Endogenous microorganisms are not able to transform all pineapple sugar into alcohol. Hence the addition of sugar and yeast allows to produce a pineapple wine with high alcohol content.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

AD contributed for the conception of the paper and did the interpretation of the data. MM revised the paper critically for intellectual content. KAA collected data for the paper. TT prepared the final draft of the paper, and after the analysis, final approval was obtained before submission.

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