ISSN: 0975 -8542

Journal of Global Pharma Technology

Available Online at: www.jgpt.co.in

RESEARCH ARTICLE

Investigation of Pineapple (*Ananas Comosus*) Wine Production

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Abstract

Pineapple is a wonderful tropical fruit having exceptional juiciness, vibrant tropical flavor and immense health benefits. Pineapples are consumed as fresh, cooked, juiced, and fermented in a wide array of food stuffs. This fruit is highly perishable and seasonal. Therefore we explored a wine fermentation from pineapple by focusing on the effect of different parameters such as Pectinex Ultra SP-L concentration and time of treatment for juice extraction, yeast inculate for wine fermentation, and secondary fermentation to wine quality. Our results proved that 0.4% Pectinex Ultra SP-L was used for juice extraction, 0.75% *sacchromyces cerevisiae* was used for the main fermentation at 11.5°C, and 3 weeks of sencondary fermentation in dark bottle at 9.5°C was applied to get a pleasant pineapple quality.

Keywords: *Pineapple, Wine, Fermentation, Sacchromyces cerevisiae, Pectinex Ultra SP-L.*

Introduction

Pineapple (*Ananas comosus*) is one of the most important commercial fruit crops in the world. It is known as the queen of fruits due to its excellent flavour and taste. The ripen pineapple fruit is consumed fresh and juice as source of essential minerals and vitamins with some medicinal values [1]. Pineapple contains considerable calcium, potassium, fibre and vitamin C. One healthy ripe pineapple fruit can supply about 16.2% of daily requirement for vitamin C [2].

Pineapple is also a good source of vitamin B1, vitamin B6, copper and dietary fibre. Fresh pineapples are rich in bromelain used for tenderizing meat. Pineapple contains a proteolytic enzyme bromelain, which digests food by breaking down protein. Various food items like jam, jelly, pickles are produced from pineapple [3]. The significant amount of polyphenols in pineapple fruit extracts and juice indicates their high antioxidant activity, thus these extracts and juice have a potential to be used in medicine prevention and treatment of various diseases [4]. The pineapple extract had an antibacterial effect towards *Staphylococcus aureus*, *Bacillus cereus*, *Klebsiella pneumonia, Pseudomonas aeruginosa, Escherichia coli, Bacillus amyloliquefaciens* due to the bromelain compound and its phytochemical factor such as Vitamin C and flavonoid [5, 8].

Effect of enzymatic hydrolysis of pineapple fruit pulp on yield and analytical parameters of derived juice was examined [9]. The effects of enzymes treatment on the colour and turbidity of pineapple juice was investigated [10]. Pineapple wine fermentation with yeasts isolated from fruit as single andmixed starter cultures was examined [11].Studies of wine produced from pineapple was mentioned [12]. De-acidifcation of fresh whole pineapple juice wine by secondary malolactic fermentation with lactic acid bacteria was evaluated [13].

Effects of processing pineapple-based must into wines by Anaerobic Fermentation (AnF) only instead of Aerobic and Anaerobic Fermentations (AAnFs) were investigated [14].
A pineapple vinification process was conducted through inoculated and spontaneous fermentation to develop a process suitable for a quality beverage [15].

Process factors for the production of alcoholic wine from pineapple fruits were successfully optimized using central composite design with the aim of minimizing the final sugar concentration of the wine [16]. Wine is an alcoholic beverage typically made of fermented fruit juice [17]. Fermentation is a process of extracting energy from the oxidation of organic compounds such as carbohydrates using an endogenous electron acceptor, usually pyruvate, an organic compound. Before fermentation takes place, one glucose molecule is broken down into two pyruvate molecules during glycolysis. Fermentation is important in anaerobic conditions when there is no oxidative phosphorylation to maintain the production of Adenosine tri-phosphate (ATP) by glycolysis. The pineapple fruit, which typically has high fermentable sugar composition when mature and ripe, could be exploited as a substrate for alcoholic fermentation [16]. Therefore, we utilized this fruit as subtrate for wine fermentation. We focused on the effect of different parameters such as Pectinex Ultra SP-L concentration and time of treatment for juice extraction, yeast inculate for wine fermentation, and secondary fermentation to wine quality.

Material & Method

Material

We collected pineapple in Kien Giang province, Vietnam. They must be cultivated following VietGAP without pesticide and fertilizer residue to ensure food safety. After harvesting, they must be conveyed to laboratory within 8 hours for experiments. Apart from collecting pineapple, we also used other materials such as Pectinex Ultra SP-L, yeast. Lab utensils and equipments included knife, weight balance, fermentation tank, refractometer, viscometer, flow UV system, pH meter, ethanol meter, buret.

Figure 1: Pineapple *(Ananas comosus)*

Research Method

Effect of Pectinex Ultra SP-L Concentration and Time for Juice Extraction

Pineapple extract was treated with Pectinex Ultra SP-L enzyme with different concentration (0.2, 0.3, 0.4, 0.5 %) in different duration (20, 20, 30, 50 minutes). We analyzed the extract recovery (%), viscosity (cP) and turbidity (mJ/cm^2).

Effect of Yeast Inculate for Wine Fermentation

Pineapple wort after being treated by Pectinex Ultra SP-L would be inoculated with *Saccharomyces cerevisiae* at different ratio (0.25, 0.50, 0.75, 1.0 %). After 10 days of fermentation at 11.5^{o}C, we analyzed the soluble dry matter (^{o}Brix), ethanol (%v/v), acidity (g/l), antioxidant activity DPPH (IC50) (mg/ml) and sensory characteristics (score) in wine.

Effect of Secondary Fermentation to Wine Quality

We preserved pineapple wine at 9.5^{o}C in dark bottle by different time (1, 2, 3, 4 weeks) as the secondary fermentation. We monitored soluble dry matted (^{o}Brix), ethanol (% v/v), acidity (g/l), antioxidant activity DPPH (IC50) (mg/ml) and sensory characteristics (score) in wine.

Statistical Analysis

Data were statistically summarized by Statgraphics Centurion XVI.

Result & Discussion

Effect of Pectinex Ultra SP-L Concentration and Time of Treatment for Juice Extraction

The enzymatic process is claimed to offer a number of advantages over mechanical-thermal comminution of several fruit pulps. Enzymes are an integral component of modern fruit juice manufacturing and are highly suitable for optimizing processes. Their main purposes are: increase extraction of juice from raw material, increase processing efficiency (pressing, solid settling or removal), and generate a final product that is clear and visually attractive. Enzymatic treatment prior to mechanical extraction significantly improves juice recovery compared to any other extraction process. Enzymatic hydrolysis of the cell walls increases the extraction yield, reducing sugars, soluble dry matter content and galacturonic acid content and titrable acidity of the products. Enzymatic degradation of the biomaterial depends upon the type of enzyme, incubation time, incubation temperature, enzyme concentration, agitation, pH and use of different enzyme combinations [18]. Pineapple extract was treated with Pectinex Ultra SP-L enzyme with different concentration (0.2, 0.3, 0.4, 0.5 %) in different duration (20, 30, 40, 50 minutes). Our results were depicted in table 1, 2 and 3. We clearly found that 0.4% Pectinex Ultra SP-L in 40 minutes treatment was optimal for pineapple extraction. So we selected these values for next experiments.

Table 1: Extract recovery (%) by diffferent Pectinex Ultra SP-L concentration (%) and time of treatment (minutes)

Pectinex Ultra SP-L concentration (%)	Extract recovery (%)			
	20 minutes	30 minutes	40 minutes	50 minutes
0.2	58.17±0.03^{b}	59.39±0.01^{ab}	60.35±0.02^{ab}	60.64±0.01^{a}
0.3	60.43±0.01^{b}	62.17±0.02^{ab}	63.24±0.01^{ab}	63.42±0.03^{a}
0.4	63.01±0.02^{b}	64.76±0.00^{ab}	66.79±0.03^{ab}	66.79±0.01^{a}
0.5	63.07±0.01^{b}	65.11±0.00^{ab}	66.71±0.01^{ab}	66.89±0.03^{a}
Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)				

Table 2: Viscosity (cP) by diffferent Pectinex Ultra SP-L concentration (%) and time of treatment (minutes)

Pectinex Ultra SP-L concentration (%)	Viscosity (cP)			
	20 minutes	30 minutes	40 minutes	50 minutes
0.2	1.03±0.02^{a}	0.92±0.02^{ab}	0.80±0.01^{ab}	0.79±0.01^{c}
0.3	0.92±0.01^{a}	0.87±0.00^{ab}	0.79±0.02^{ab}	0.77±0.01^{c}
0.4	0.87±0.02^{a}	0.88±0.01^{ab}	0.75±0.01^{ab}	0.75±0.03^{c}
0.5	0.79±0.00^{a}	0.78±0.03^{ab}	0.75±0.01^{ab}	0.75±0.00^{c}
Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)				

Table 3: Turbidity (mJ/cm²) by diffferent Pectinex Ultra SP-L concentration (%) and time of treatment (minutes)

Pectinex Ultra SP-L concentration (%)	Optical density (mJ/cm²)			
	20 minutes	30 minutes	40 minutes	50 minutes
0.2	71.79±0.01^{a}	69.37±0.01^{ab}	67.17±0.01^{ab}	67.09±0.01^{b}
0.3	69.58±0.02^{a}	67.17±0.03^{bb}	65.30±0.03^{ab}	64.41±0.02^{b}
0.4	67.23±0.02^{a}	65.29±0.02^{ab}	63.76±0.04^{ab}	63.60±0.01^{b}
0.5	67.14±0.01^{a}	65.31±0.01^{ab}	63.75±0.00^{ab}	63.65±0.02^{b}
Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)				

Effect of enzymatic hydrolysis of pineapple fruit pulp on yield and analytical parameters of derived juice was examined. Both pectinolytic and cellulolytic enzyme treatment of pineapple pulp showed significant improvement of juice yield. Individual effects yielded only 6% more juice whereas combined enzyme preparations yielded about 15 % more juice over control. Besides juice yield, enzyme treatment was found advantageous in increasing total soluble solids and clarification of juice (M. G. Aziz) [9]. Enzymatic pectinase application in extraction and purification of juice turbidity from red rose apple pulp (*Syzygium malaccensis*) was investigated. Pectinex Ultra SP-L ratio 0.04%, temperature 30 oC in 60 minutes for rose apple pulp extraction; Pectinex 3XL ratio 0.03%, temperature 40 oC in 80 minutes for rose apple juice clarification was optimal [19]. Two commercial enzyme preparations (from *Aspergillus niger*), a pectinase and a liquid pectinase/ hemicellulases were used singly or in combination at a rate 0.03% (w/w) in a two step extraction of pineapple juice at 35, 37.5 and 40oC for 30 min. The percentage juice recovery, soluble sugars, total phenolics,

titratable acidity, viscosity and turbidity of the recovered juice were measured to ascertain the influence of the enzyme preparations on extraction against the control [20]. The effects of enzymes treatment on the colour and turbidity of pineapple juice was investigated.

The turbidity and colour of pineapple juice significantly ($p<0.05$) increased after pectinase treatment.A combination of pectinase and hemicellulase increased the turbidity of the juice when compared with the control but hemicellulase significantly ($P<0.05$) reduced the colour of the juice. Both pectinase and hemicellulase hydrolyse the fibres of the pineapple and will release soluble solids into the system thus increasing the turbidity of the system [10].

Effect of Yeast Inculate for Wine Fermentation

Alcoholic fermentation is a combination of complex interactions involving must variety, micro biota and winemaking technology. Some factors strongly affect alcoholic fermentation, and consequently the quality of the wine. The most important factors are the clarification of the juice, the temperature of fermentation, the composition of the juice, inoculation with selected yeasts and the interaction with other microorganisms [21].

Pineapple wort after being treated by Pectinex Ultra SP-L would be inoculated with *Saccharomyces cerevisiae* at different ratio (0.25, 0.50, 0.75, 1.0 %). After 10 days of fermentation at 11.5°C, we noticed the change of soluble dry matter (°Brix), ethanol (%v/v), acidity (g/l), antioxidant activity DPPH (IC50) (mg/ml) and sensory characteristics (score) in wine as in table 4, 5, 6, 7 and 8. We found that the approprate yeast inculate should be 0.75% to get the highest wine quality.

Table 4: Effect of yeast ratio to soluble dry matter (°Brix) in wine

Fermentation time (days)	Soluble dry matter in wine (oBrix)			
	Yeast ratio 0.25%	Yeast ratio 0.5%	Yeast ratio 0.75%	Yeast ratio 1.0%
1	17.57±0.02^{a}	16.41±0.02^{b}	16.26±0.01^{c}	16.08±0.01^{d}
2	16.30±0.01^{a}	15.37±0.01^{b}	14.52±0.02^{c}	15.81±0.02^{d}
3	15.14±0.01^{a}	14.33±0.03^{b}	13.13±0.02^{c}	14.71±0.00^{d}
4	13.80±0.03^{a}	12.89±0.02^{b}	12.24±0.01^{c}	13.42±0.01^{d}
5	12.41±0.01^{a}	11.81±0.01^{b}	11.40±0.01^{c}	12.20±0.03^{d}
6	11.08±0.04^{a}	10.49±0.01^{b}	11.80±0.03^{c}	10.88±0.02^{d}
7	10.97±0.02^{a}	10.47±0.01^{b}	11.75±0.00^{c}	10.82±0.02^{d}
8	10.17±0.02^{a}	9.90±0.02^{b}	11.11±0.00^{c}	10.68±0.01^{d}
9	9.71±0.01^{a}	9.14±0.01^{b}	10.52±0.00^{c}	9.25±0.03^{d}
10	9.09±0.03^{a}	8.53±0.01^{b}	9.79±0.02^{c}	8.51±0.04^{d}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Table 5: Effect of yeast ratio to ethanol formation (%v/v) in wine

Fermentation time (days)	Ethanol in wine (%v/v)			
	Yeast ratio 0.25%	Yeast ratio 0.50%	Yeast ratio 0.75%	Yeast ratio 1.0%
1	3.09±0.02^{d}	3.60±0.02^{c}	4.44±0.02^{b}	4.49±0.02^{a}
2	3.30±0.01^{d}	3.91±0.01^{c}	4.47±0.00^{b}	4.80±0.01^{a}
3	4.34±0.01^{d}	4.39±0.03^{c}	4.99±0.03^{b}	5.11±0.00^{a}
4	4.36±0.01^{d}	4.83±0.01^{c}	5.07±0.01^{b}	5.12±0.02^{a}
5	4.94±0.00^{d}	5.09±0.02^{c}	5.30±0.01^{b}	5.34±0.02^{a}
6	5.19±0.01^{d}	5.27±0.01^{c}	5.44±0.03^{b}	5.47±0.01^{a}
7	5.24±0.03^{d}	5.30±0.00^{c}	5.49±0.02^{b}	5.49±0.02^{a}
8	5.29±0.01^{d}	5.37±0.01^{c}	5.50±0.04^{b}	5.55±0.01^{a}
9	5.40±0.02^{d}	5.44±0.03^{c}	5.58±0.01^{b}	5.68±0.03^{a}
10	5.49±0.01^{d}	5.50±0.00^{c}	5.69±0.02^{c}	5.80±0.01^{a}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Table 6: Effect of yeast ratio to acidity (g/l) in wine

Fermentation time (days)	Acidity in wine (g/l)			
	Yeast ratio 0.25%	Yeast ratio 0.50%	Yeast ratio 0.75%	Yeast ratio 1.0%
1	1.15±0.02^{c}	1.27±0.01^{b}	2.02±0.02^{ab}	2.06±0.02^{a}
2	1.17±0.01^{c}	1.30±0.02^{b}	2.05±0.01^{ab}	2.11±0.03^{a}
3	1.48±0.02^{c}	1.99±0.01^{b}	2.16±0.00^{ab}	2.25±0.01^{a}
4	1.80±0.01^{c}	2.07±0.00^{b}	2.30±0.01^{ab}	2.40±0.01^{a}
5	2.04±0.03^{c}	2.20±0.01^{b}	2.34±0.02^{ab}	2.43±0.03^{a}
6	2.23±0.02^{c}	2.35±0.03^{b}	2.42±0.01^{ab}	3.00±0.02^{a}
7	2.25±0.00^{c}	2.39±0.02^{b}	2.45±0.00^{ab}	3.05±0.01^{a}
8	2.31±0.01^{c}	2.57±0.01^{b}	2.77±0.03^{ab}	3.16±0.01^{a}
9	2.35±0.02^{c}	2.83±0.01^{b}	2.98±0.04^{ab}	3.27±0.02^{a}
10	2.50±0.01^{c}	2.90±0.03^{b}	3.10±0.02^{ab}	3.33±0.00^{a}
Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)				

Table 7: Effect of yeast ratio to antioxidant activity, DPPH (IC50) **(mg/ml) in wine**

Fermentation time (days)	**Antioxidant,** DPPH (IC50) **(mg/ml) in wine**			
	Yeast ratio 0.25%	Yeast ratio 0.50%	Yeast ratio 0.75%	Yeast ratio 1.0%
1	1.19±0.01^{c}	1.30±0.02^{b}	2.06±0.01^{ab}	2.11±0.01^{a}
2	1.20±0.03^{c}	1.32±0.01^{b}	2.09±0.02^{ab}	2.15±0.00^{a}
3	1.50±0.02^{c}	2.02±0.02^{b}	2.19±0.01^{ab}	2.28±0.03^{a}
4	1.83±0.00^{c}	2.09±0.03^{b}	2.35±0.02^{ab}	2.43±0.00^{a}
5	2.07±0.01^{c}	2.23±0.00^{b}	2.39±0.01^{ab}	2.46±0.00^{a}
6	2.27±0.03^{c}	2.39±0.01^{b}	2.47±0.03^{ab}	3.04±0.03^{a}
7	2.29±0.02^{c}	2.41±0.00^{b}	2.51±0.01^{ab}	3.09±0.02^{a}
8	2.34±0.03^{c}	2.60±0.03^{b}	2.80±0.02^{ab}	3.19±0.02^{a}
9	2.40±0.00^{c}	2.86±0.02^{b}	3.01±0.01^{ab}	3.30±0.01^{a}
10	2.53±0.01^{c}	2.94±0.01^{b}	3.13±0.01^{ab}	3.35±0.01^{a}
Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)				

Table 8: Effect of yeast ratio to soluble dry sensory characteristics (score, 1-5) in wine

Fermentation time (days)	**Sensory score of wine (1-5) by different yeast ratio**			
	Yeast ratio 0.25%	Yeast ratio 0.50%	Yeast ratio 0.75%	Yeast ratio 1.0%
1	2.51±0.03^{c}	3.05±0.03^{b}	4.19±0.02^{ab}	4.71±0.02^{a}
2	2.53±0.01^{c}	3.17±0.00^{b}	4.25±0.01^{ab}	4.72±0.03^{a}
3	2.99±0.02^{c}	3.29±0.01^{b}	4.38±0.03^{ab}	4.75±0.00^{a}
4	3.18±0.02^{c}	3.83±0.03^{b}	4.46±0.01^{ab}	4.77±0.01^{a}
5	3.71±0.01^{c}	4.01±0.01^{b}	4.49±0.02^{ab}	4.79±0.03^{a}
6	4.19±0.04^{c}	4.32±0.01^{b}	4.71±0.01^{ab}	4.83±0.01^{a}
7	4.22±0.01^{c}	4.36±0.02^{b}	4.76±0.01^{ab}	4.85±0.03^{a}
8	4.33±0.02^{c}	4.63±0.01^{b}	4.79±0.03^{ab}	4.88±0.02^{a}
9	4.49±0.02^{c}	4.67±0.04^{b}	4.84±0.01^{ab}	4.94±0.00^{a}
10	4.59±0.03^{c}	4.80±0.01^{b}	4.90±0.02^{ab}	4.98±0.03^{a}
Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)				

Pineapple wine fermentation with yeasts isolated from fruit as single andmixed starter cultures was examined. The pineapple juice was fermented with single andmixed starter cultures of Saccharomyces cerevisiae, Saccharomycodes ludwigii and Hanseniaspora isolated at 25oC for 10 days [11]. Studies of wine produced from pineapple were mentioned. The ratio of 1: 4 (pineapple must: sugar) was used to produce wine using recipes A to D. A contained only natural yeast; B contained natural yeast augmented with granulated sugar; C contained natural yeast augmented with baker's yeast and granulated sugar while D (control) contained granulated sugar and baker's yeast.

Wines produced after 144 h of fermentation had average values of 3.44, 3.32, 3.46 and 3.50 for pH; 0.583, 0.627, 0.715 and 0.666 for optical density; 0.999, 1.003, 0.998 and 0.993 for specific gravity; 6.67, 6.69, 6.75 and 6.72 for total aerobic count (Log10 cfu/ml); 1.355, 1.355, 1.350 and 1.350 for % alcohol and 0.956, 1.246, 0.997 and 0.260 for %.titratable acidity for A to D respectively. The mean values for temperature and Rf were 30.5°c and 0.6 respectively. Malo-lactic fermentation after 48 h was evident. Taste testing showed very little differences in the wines with recipes A to C while statistical analyses at 95% confidence level showed no significant differences.

The wine from the control had similar taste and characteristics with natural palm wine [12]. Effects of processing pineapple-based must into wines by Anaerobic Fermentation (AnF) only instead of Aerobic and Anaerobic Fermentations (AAnFs) were investigated. Control musts were subjected to aerobic fermentation, ANF and

clarification for 7, 83 and 30 days, respectively. Test musts clarified in the course of 90 days AnF. Wines produced by AAnFs were more acidic (pHtest = 3.17±0.01, pHcontrol = 3.28±0.01, $p<0.05$), had more total acids (test = 0.70±0.01 g tartaric acid/100 mL, control = 0.66±0.00 g tartaric acid/100 mL, $p<0.05$), fixed acids (test = 0.49±0.02 g malic acid/100 mL, control = 0.39±0.01 g malic acid/100 mL, $p<0.05$), alcohol (test = 12.72±0.01%, control = 11.36±0.00%, $p<0.05$).

Furthermore, wines produced by AnF had more volatile acids (test = 0.39±0.00 g acetic acid/100 mL, control = 0.33±0.01 g acetic acid/100 mL, $p<0.05$) and glucose (test = 1.50±0.01 g/100 mL, control = 1.40±0.00 g/100 mL, $p<0.05$) [14]. Process factors for the production of alcoholic wine from pineapple fruits were successfully optimized using central composite design with the aim of minimizing the final sugar concentration of the wine.

The optimum conditions obtained were; yeast concentration of 7.46g/l, pH of 5.43, initial sugar concentration of 23%brix and fermentation time of 11days with predicted final sugar concentrations of 7.778% brix at 9.8 desirability [16].

Effect of Secondary Fermentation to Wine Quality

To improve the acidic taste, the deacidifcation of the ethanolic fermentation (wine) by subsequent secondary malolactic fermentation with lactic acid bacteria (LAB), which has generally been practiced in grape wine making, is a potential approach. This reaction is widely encouraged by malolactic fermentation in fruit wines.

We preserved pineapple wine at 9.5°C in dark bottle by different time (1, 2, 3, 4 weeks) as the secondary fermentation. We monitored soluble dry matted (°Brix), ethanol (% v/v), acidity (g/l), antioxidant activity DPPH (IC50) (mg/ml) and sensory characteristics (score) in wine.

Our results were elaborated in Table 9. We noted that the longer of the secondary fermentation, the better of wine quality we got. However, there was not significant change of samples being preserved at the 3rd and 4th week so we choosed 3 weeks of secondary fermentation for economy. The performance of secondary fermentation in the de-acidifcation of wine can improve the pineapple wine quality.

Table 9: Effect of the sencondary fermentation to wine quality

Criteria	Secondary fermentation (weeks)			
	1	2	3	4
Soluble dry matter (°Brix)	12.60±0.01^{a}	12.49±0.02^{ab}	12.41±0.01^{ab}	12.09±0.02^{c}
Ethanol (%v/v)	4.70±0.02^{b}	4.92±0.00^{ab}	5.11±0.03^{ab}	5.45±0.01^{a}
Acidity (g/l)	2.41±0.01^{b}	2.42±0.01^{ab}	2.44±0.02^{ab}	2.48±0.03^{a}
Antioxidant activity DPPH (IC50) (mg/ml)	3.19±0.02^{b}	3.21±0.01^{ab}	3.28±0.01^{ab}	3.34±0.01^{a}
Sensory score	4.72±0.01^{b}	4.79±0.02^{ab}	4.82±0.00^{a}	4.83±0.00^{a}
Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)				

De-acidifcation of fresh whole pineapple juice wine by secondary malolactic fermentation with lactic acid bacteria was evaluated. Pineapple juice was primary fermented with a mixed yeast of *Saccharomycodes ludwigi*i S1 and *Hanseniaspora uvarum* TISTR5153 at 25–30oC for 7 d and then secondary lactic acid bacteria fermented with *Oenococcus oeni* LALVIN 31TM and/or *O. oeni* Enoferm® ALPHA at 25–30 oC for 4 weeks.

Optimal secondary fermentation was found in the co-presence of both lactic acid bacteria, which decreased the malic acid content to 5.58 g/L forming lactic acid (4.39 g/L). The secondary ferment still contained 10% (v/v) alcohol but had a higher total titratability acid (10.6 g/L) and pH (3.80).

The sensory score of the wine after fermentation with both lactic acid bacteria isolates was increased and this was higher than when fermented with either lactic acid bacteria alone [13]. In another research, **t**he fermentation process of pineapple fruit wine was studied. The juice was inoculated with 5% (v/v) active yeast and held at 20 °C for 7 days.

Total sugar and pH decreased while the alcoholic strength increased with increasing length of fermentation.

The fermented fruit wine contains 2.29 g/L total acid, 10.2 % (v/v) alcohol, 5.4 °Brix soluble solids, pH 3.52. Pineapple wine detected 68 kinds of aroma components, including 34 esters, 13 alcohols. The ester material accounted for 52.25% of the main aroma components [22].

Conclusion

Pineapple contains considerable amount of calcium, potassium, vitamin C, carbohydrates, crude fibre, water and different minerals that is good for the digestive system and helps in maintaining ideal weight and balanced nutrition Pineapple fruits exhibit high moisture, high sugars, soluble solid content ascorbic acid and low crude fibre. Mature and ripe pineapplees with their high composition of fermentable reducing sugars such as glucose, sucrose and fructose could serve as substrates for fruit wine production using wine yeast (*Saccharomyces cerevisiae*), thus transforming a perishable products to more stable and value added product.

Pineapple-based must processed into wines by anaerobic fermentation produced organoleptically preferred good quality white dry table pineapple wines with lower derivable energy content. The processing of fruit wine is not only satisfies people's consumption demand but also makes the value of pineapple can be improved. Therefore, production of wine from this fruit can help increase wine variety and reduce post-harvest losses.

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