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Production and Quality Improvement of the Tropical Fruit Tamarind (*Tamarindus indica* Linn.) Wine

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Abstract Tamarind (*Tamarindus indica* Linn.) is one of the most popular tropical fruit with many benefits in Thailand. It have been used as a food ingredient for a long time and has many therapeutic properties. Therefore, The research finding was to produce and improve the quality of tamarind wine. The two varieties of *Saccharomyces cerevisiae* var. *burgundy* and *montachae* were chosen for tamarind wine fermentation. Both varieties produced similar percentages of alcohol by volume but for the sensory evaluation showed that *montachae* was better than *burgundy* with the 3.87 ± 0.10 points. The optimal conditions for production of tamarind wine was 10% inoculum concentration, 5% tamarind juice and 20 °Brix total soluble solid with the 0.67 percentage of alcohol by volume and 3.63 ± 0.10 points from sensory evaluation. Then the quality of tamarind wine was improved by mixing tamarind juice with pineapple juice and roselle juice. The result showed that, production of wine using only tamarind juice was obtained the maximum sensory evaluation result with 3.58 ± 0.24 points. In conclusion, tamarind can be used as substrate for production of wine. It will be meet an alternative way to add value to tamarind. Moreover, the produced tamarind wine had a good taste which the acceptance from the consumers without the quality improvement.

Keywords: Tamarind, Wine production, Sensory evaluation, *Saccharomyces cerevisiae*.

Introduction

Wine is an alcoholic beverage producing by fermentation of yeast, *Saccharomyces cerevisiae* in fruit juice. In general, grape is the most popular fruit for wine production because grape juice is rich of carbon sources, nutrients and enzyme for yeast fermention. Yeast grows and converts sugar in fruit juices into alcohol and carbondioxide. In the present, home-made wine production has

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been used various fruits including banana, apple, pineapple, cherry, berry, banana, cashew apple, pawpaw, water melon and orange (Obaedo and Ikenebomeh, 2009; Archibong *et al.*, 2015; Ogodo *et al.*, 2015; Lowor *et al.*, 2016) or local fruits which obtained the different flavor, aroma and taste based on type of fruit. Wine has great health benefits similar to those of fruits from which they are derived.

Tamarind (*Tamarindus indica* Linn.) is a tropical fruit which originated from Africa. In Thailand is well-known in the name of "Makham". Tamarind tree is grown in every parts of Thailand both for export and domestic consumption. The edible tamarind pulp contains of many nutrients such as phosphorus, calcium, vitamin A and C, citric acid, malic acid and tartaric acid (El-Sidding *et al.*, 2006; Gupta *et al.*, 2014) with a little acidic taste. In addition, the antimicrobial activity of tamarind pulp extract against food spoilage microorganisms including *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Bacillus subtilis*, *Listeria monocytogenes*, *Escherichia coli*, *Enterobacter aerogenes* and *Pseudomonas aeruginosa* have been reported (Gupta *et al.*, 2014). Due to its unique properties, tamarind has been used as a flavouring agent, stabilizer and binder in many foods (Tsuda *et al.*, 1994; Siddhuraju *et al.*, 1995). Tamarind pulp is also used for producing of beverage and table wine (Mbaeyi-Nwaoha and Ajumobi, 2015; Mohamed *et al*., 2015).

Therefore, in the present study was to use of acidic rip tamarind pulp as raw material for production of wine. The factors effecting on quality of wine including yeast strain, initial total soluble solid, concentrations of inoculum and tamarind juice were studied. Improvement of wine quality was also performed by fermentation of tamarind juice with other fruit juices to obtained higher quality and better taste.

Materials and methods

Microorganism

Saccharomyces cerevisiae var. *montachae* and *S. cerevisiae* var. *burgundy* were obtained from Deparment of Applied Science and Biotechnology, Faculty of Agro-Industrial Technology, Rajamangala University of Technology Tawan-OK Chantaburi Campus. They were maintained on potato dextrose agar (PDA) slant and kept at 4°C until further use.

Raw material and preparation of fermentation medium

Rip tamarind was purchased from local market at Klao Kitchakut, Chanthaburi, Thailand. Five percentages of rip edible tamarind pulp were mixed with distilled water and total soluble solid (TSS) was adjusted to 18°Brix. Tamarind juice were steriled by boiling for 15 minutes.

Preparartion of inoculum and culture condition

Both microorganisms were separately grown on PDA agar plates at 30°C for 48 hours. Next, they were separately transferred into 250-ml Erlenmeyer flask containing 150 ml of steriled pineapple juice with 18°Brix TSS, pH 4.0. Then these flasks were incubated at 30°C under shaking condition at a speed of 50 rpm for 24 hours and used as inoculum. For fermentation of wine 15 ml of inoculum was transfer into 500-ml Erlenmeyer flasks containing 385 ml of steriled fermentation medium. The flasks were incubated under static condition at room temperature for 10 days.

Optimization of culture condition for tamarind wine production

In order to obtain tamarind wine with the acceptance from the consumer, the culture conditions were adjusted by varying one factor at a time (OFT). The fermentation parameters including microbial variety, TSS, concentrations of inoculum and tamarind juice were optimized. The samples were collected at 0, 5 and 10 days of fermentation for analysis of ethanol concentration, TSS and sensory evaluation.

Quality improvement of tamarind wine

The quality of tamarind wine was improved by mixing tamarind juice with pinapple juice and roselle juice. The three recipes including (1) only tamarind juice (optimal concentaion), (2) tamarind juice (optimal concentration) with pinapple juice (5%) and (3) tamarind juice (optimal concentration) with roselle juice (5%) were tested.

Analysis of tamarind wine

The concentration of ethanol in the sample was analyzed using ebulliometer. TSS was determined by hand refractometer. Sensory attribute including color, odor and taste were evaluated using a five-point hedonic scale (where 5 like and 1 dislike) by 20 panellists (10 males and 10 females) with age group: 20-30 years old.

Statistical analysis

The statistical significance of the sensory evaluated data was analyzed by one-way analysis of variance (ANOVA) using PASW Statistics software (version 18.0). The comparison of sensory evaluation between wine obtained from *S. cerevisiae* var. *montachae* and var. *burgundy* was statistically analyzed by student's *t*-test. Differences among the mean values were tested by Duncan's test at 95% confidence level (p <0.05).

Results

Production of tamarind wine using different varieties of S. cerevisiae

Fermentaion of tamarind wine using the two varieties of *S. cerevisiae* including *S. cerevisiae* var. *burgundy* and *montachae* were performed with 20 °Brix TSS, 5% inoculum concentration, pH 6.0 and incubation at 30°C for 10 days. The result showed that tamarind wine using *burgundy* gave higher alcohol (0.97% v/v) than *montachae* (0.93% v/v). The TSS was reduced to 14.07 and 14.13 °Brix when using *burgundy* and *montachae*, respectively at the end of fermentation. The tamarind wine using *montachae* gave the greater significantly average acceptance of 4.00 ± 0.32 points than 3.40 ± 0.50 points of *burgundy* (p<0.05) (Table 1). Therefore, *montachae* was selected for further experiment.

Table 1. Sensory evaluation result of the tamarind wine production using different varieties of *S. cerevisiae*

Yeast	Sensory evaluation result (Mean±SD)			
	Odor	Color	Taste	Average
burgundy	3.35 ±0.49	3.45 ±0.51	3.65±0.81	0.50± 3.40
montachae	3.75 ±0.55*	3.70 ±0.47	4.15 ±0.67*	0.32±4.00*

Data were analysed using student's *t*-test.
* Significant (p < 0.05)

Effect of different concentrations of inocula

The different inoculum concentrations of 1%, 5%, 10% and 15% (v/v) were tested for tamarind wine fermentation with 20 °Brix TSS, pH 6.0 and 5% (w/v) tamarind juice at 30°C using *montachae* for 10 days. The tamarind wines gave alcohol content of 0.33, 0.83, 1.03 and 1.13% (v/v) in 1%, 5%, 10% and 15% inoculum concentrations, respectively and TSS was redeuced to 13.07-

16.67 °Brix. Using 10% inoculum concentration showed the highest average acceptance of 4.17 ± 0.46 points with no significant difference among 10%, 5% (3.70±0.13 points) and 15% (3.87±0.13 points). When considering only the taste 10% inoculum concentration indicated the highest significantly of 4.70±0.47 points (p<0.05) then it was selected (Table 2).

Table 2. The sensory evaluation result of the tamarind wine production using different inoculum concentrations

Concentration of inoculum (% v/v)	Sensory evaluation result (Mean±SD)			
	Odor	**Color**	**Taste**	**Average**
1	3.60±0.50^{b}	3.50±0.69^{c}	3.00±0.51^{c}	3.35±0.35^{b}
5	3.85±0.37^{ab}	3.65±0.49^{bc}	3.60±0.75^{b}	3.70±0.13^{ab}
10	3.90±0.31^{a}	3.90±0.45^{ab}	4.70±0.47^{a}	4.17±0.46^{a}
15	3.75±0.44^{ab}	3.85±0.49^{a}	4.00±0.73^{b}	3.87±0.13^{a}

Any two mean values bearing the same superscript in the same column are not significantly different (p<0.05)

Effect of different concentrations of tamarind juice

The tamarind wine was produced using *montachae* with 10% inoculum concentration, 20 °Brix of TSS, pH 6.0 and different concentrations of tamarind juice (5%, 10% and 15% w/v) at 30°C. After 10 days of fermentation, 15% tamarind juce gave the highest percentage alcohol of 1.23 followed by 10% (1.03% alcohol) and 5% (0.83% alcohol), respectively. The TSS in all experiments were reduced to 8.52-14.13 °Brix. For the sensory evaluation, the highest of 3.78±0.25 points was obtained using 5% tamarind juice but no significant difference with 10% tamarind juice (Table 3). In order to reduce the production cost 5% tamarind juice was chosen.

Table 3. The sensory evaluation result of the tamarind wine production using different concentrations of tamarind juice

Concentration of tamarind juice (%w/v)	Sensory evaluation result (Mean±SD)			
	Odor	**Color**	**Taste**	**Average**
5	3.55±0.51^{a}	3.75±0.64^{a}	4.05±0.60^{a}	3.78±0.25^{a}
10	3.45±0.69^{a}	3.50±0.76^{ab}	3.85±0.75^{a}	3.60±0.22^{a}
15	3.25±0.55^{a}	3.15±0.59^{b}	3.30±0.87^{b}	3.23±0.08^{b}

Any two mean values bearing the same superscript in the same column are not significantly different (p<0.05)

Effect of different concentrations of TSS

The different concentrations of 16, 18 and 20°Brix TSS were studied for tamarind wine production with 10% inoculum concentration, pH 6.0, 5% tamarind juice using *montachae* and incubation at 30°C for 10 days. The 16°Brix TSS showed the highest alcohol content of 1.13% followed by 18 and 20°Brix, respectively. The use of initial TSS of 16, 18 and 20°Brix were reduced to 8.93, 10.13 and 12.87°Brix, respectively at the end of fermentation. Using of 20°Brix TSS gave the highest average sensory evaluation result of 3.63±0.10 points but no significant difference with 18 °Brix TSS. In addition, when considering sensory evaluation result in each point (odor, color and taste) indicated that 20°Brix TSS obtained better score than 18°Brix TSS in all points (Table 4).

Table 4. The sensory evaluation result of the tamarind wine production using different concentrations of TSS

Concentration of TSS (°Brix)	**Sensory evaluation result (Mean±SD)**			
	Odor	**Color**	**Taste**	**Average**
16	3.00 ± 0.86^{b}	3.10 ± 0.79^{b}	3.35 ± 0.77^{a}	3.15 ± 0.18^{b}
18	3.20 ± 0.77^{ab}	3.35 ± 0.67^{ab}	3.60 ± 0.50^{a}	3.38 ± 0.20^{a}
20	3.55 ± 0.60^{a}	3.60 ± 0.50^{a}	3.75 ± 0.72^{a}	3.63 ± 0.10^{a}

Any two mean values bearing the same superscript in the same column are not significantly different (p<0.05)

Quality improvement

The quality of tamarind wine was improved by mixing rip tamarind juice with pinapple juice and roselle juice. The mixing of tamarind juice with roselle juice obtained the highest alcohol content of 1.13% followed by tamarind juice, and tamarind juce with pineapple juice. The produced wine using only tamarind juice showed the highest sensory evaluation result of 3.58±0.27 points but no significant difference with using tamarind juice mixed with pineapple juice. When focusing only the taste, using only tamarind juice gave the highest significantly sensory evaluation result (Table 5).

Table 5. The sensory evaluation result of the produced wines

Sample	Sensory evaluation result (Mean±SD)			
	Odor	Color	Taste	Average
Tamarind juice	3.50 ±0.51^{a}	3.40 ±0.50^{a}	3.85 ±0.59^{a}	3.58 ±0.24^{a}
Tamarind juice mixed with pineapple juice	3.15 ±0.75^{ab}	3.31 ±0.73^{a}	3.30 ±0.66^{b}	3.25 ±0.09^{ab}
Tamarind juice mixed with roselle juice	3.05 ±0.60^{b}	3.30 ±0.66^{a}	2.75 ±0.44^{c}	3.03 ±0.28^{b}

Any two mean values bearing the same superscript in the same column are not significantly different (p<0.05)

Discussion

The properties of wine including odor, color, taste and chemical composition are depened on yeast stain, fermentation parameters and type of fruits. Different fruits have different components such as type of sugar and acetic acid concentration that could be used by yeast at the optimal condition for converting to alcohol, organic acids, aldehyde, ester and other substances (Fleet 2003; Duarte *et al.*, 2010). *Saccharomyces* is the most popular yeast use for production of wine. Therefore, the two varieties *burgundy* and *montachae* of *S. cerevisiae* were used to produce tamarind wine in this study. The alcohol content in all experiments were increased and TSS was decresed from the first day to the last day of fermentation. However, the alcohol content obtained in the wines were low ranging (0.33-1.23% v/v) and the TSS was still high (8.52-14.13°Brix). This could be attributed to the efficiency of yeast in the fermentation similar to the report of Yabaya *et al*. (2016) and the fermentation time was too short. The higher alcohol content was obtained in *burgundy* but the highest sensory evaluation result was obtained in *montachae*.

Effect of different inoculum concentrations indicated that increased the inoculum concentration result in the increased of alcohol content. The result showed that when the concentration of yeast was increased, yeast cells converted more sugar to alcohol. However, at the higher inoculum concentration yeast cells grew not well because of the limited nutrient and were not able to convert more sugar in to it. The results obtained were agreed with the report of Satav and Pethe (2017) who studied wine production from banana fruits. In this study, 10% and 15% inoculum concentration gave similar alcohol content but 10% showed the better taste than 15%.

The use of different concentrations of tamarind juice obtained the different alcohol contents. The increased alcohol content was received in the increased of tamarind juice concentration. However, the highest sensory score was obtained in the lowest tamarind juice concentration (5%) and alcohol content.

Effect of different concentrations of TSS, the alcohol content was decreased when concentration of TSS was increased from 16-20 °Brix. The increased of TSS resulted in the increased of sugar or carbon source level that could be used by yeast to grow and produce alcohol. In contrast, inhibition of cell growth and alcohol production were occurred in the higher of TSS as the substrate inhibition. Different results were obtained in Singh and Kaur (2009) who studied wine production from litchi juice. They found that TSS was increased from 20-24 °Brix giving the higher alcohol content. However, productivity of alcohol is based on microbial stain. The TSS 20°Brix obtained the greatest sensory evaluation results with the lowest alcohol content.

The quality of tamarind wine was improved by the combination of tamarind juice with other fruit juices. The highest alcohol content was obtained from tamarind juice with the roselle juice. This might be due to the roselle juice has high nutrient such as phosphorus, calcium, manganese and magnesium which stimulated faster fermentation. The use of only tamarind juice obtained the higest sensory evaluation result with is similar to Mbaeyi-Nwaoha and Ajumobi (2015) who evaluated sensory properties of table wine from tamarind and soursop. They found that using only tamarind juice or soursoup gave the overall acceptability score better than using the combination of both fruit juices. From our results indicated that tamarind wine with the low alcohol was acceptable in the consumer age ranging 20-30 years old.

In conclusion, this study reveals that tamarind can be used as raw material for production of wine with the low alcohol content. It will be an alternative way to add value to tamarind and produce a healthy benefits wine for consumers. Moreover, the produced tamarind wine had a good taste which the acceptance from the consumers without the quality improvement.

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