Development of Nipa Sap Vinegar Drink

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Abstract

This work aimed to develop vinegar drink from nipa sap vinegar. Firstly, nipa sap or juice obtained from the fruit stalks of nipa palm was fermented into vinegar. Then 4 prototyped formulations of vinegar drink were developed by mixing the vinegar with nipa sap, butterfly pea extract, roselle-jujube (Chineses date) juice, and gac fruit juice. Honey was used as a sweetener in all formulas except nipa sap formula. The just-about-right scale (JAR) was used to evaluate the prototypes regarding the level of color, sourness and sweetness. The results from 50 panelists revealed that nipa sap and gac fruit formula were rated at just right while butterfly pea formula needed lower color intensity and roselle-jujube formula needed more sweetness. The results from 9-point Hedonic scale from 100 panelists indicated that the overall acceptance scores of the developed products were 7.45, 7.71, 7.82, and 7.83, respectively (like moderately to like very much). The optimal nipa sap formula consisted of 7.69% vinegar and 92.31% nipa sap while butterfly pea and gac fruit formula consisted of 7.69% vinegar, 11.54% honey and 80.77% butterfly pea extract or gac fruit juice. The optimal roselle-jujube formula consisted of 7.69% vinegar, 15.38% honey and 76.92% roselle-jujube juice.

Keywords: Vinegar drink, nipa sap, butterfly pea, roselle-jujube, gac fruit

1. Introduction

Vinegar is a sour liquid used as a cooking ingredient or food condiment in everyday life. It is produced from raw materials containing starch or sugar via sequential ethanol and acetic acid fermentations. Firstly, the simple sugars in raw material are converted to alcohol by yeasts. Then, the alcohol is further oxidized to acetic acid by acetic acid bacteria (Krusong and Pongsawatmanit, 1989). According to the Notification of the Ministry of Public Health No. 204 B.E. 2543 (NMPH 204-2543), vinegar is classified into 3 types namely (1) fermented vinegar, (2) distilled vinegar and (3) diluted glacial acetic vinegar.

Another useful aspect of the natural vinegar product besides the food ingredient has long been considered. Recently, the potential health benefits of vinegar varieties due to its functional properties and bioactive substances are reported by many researchers (Johnston and Gaas, 2006; Budak *et al*., 2014; Rezai *et al*., 2016). Institute of Food Research and Product Development (2013) also reported that drinking of vinegar mixed with honey and warm water could refresh the body and help to improve many body systems. The report on the analysis of the investment possibility on fermented vinegar from pineapple by Office of Industrial Economics mentioned the benefit of vinegar drinking that it can slow down

aging, detox, promote Ca utilization, balance weight, balance body pH and helps in excretion (Office of Industrial Economics, 2012).

In Phra Samut Chedi district, Samut Prakarn province, there are several nipa palm clusters growing naturally in many areas. The local people have made many uses of nipa palm, for example, nipa leaves for basketry, thatching and wrapping tobacco for smoking; flower stalks for making mosquito whisk; and young fruits for dessert and drink. A previous research was conducted on the production of vinegar from nipa sap or juice obtained from the fruit stalks of nipa palm via the rapid-tray-culture method (Thepwiwatjit, 2016). It was found that the alcohol fermentation took 9 days and provided nipa wine with 12.1% ethyl alcohol. The vinegar fermentation was accomplished in 7 days at ambient temperature and yielded 5.7% acetic acid. This study aimed to add value onto the nipa sap vinegar through the development of a vinegar drink by combining the benefit of the vinegar with some healthful photochemicals from other ingredients such as anthocyanins from butterfly pea and roselle and beta-carotene and lycopene from gac fruit.

2. Research Objectives

To develop the optimal formulation of vinegar drink from nipa sap vinegar

3. Research Methodology

3.1 Nipa sap vinegar fermentation

The nipa sap vinegar fermentation was conducted using the method as described by Thepwiwajit (2016). Briefly, the nipa sap of 22-25°Brix and a pH of 3.5-4.0 was fermented to ethyl alcohol at ambient temperature for 7- 10 days until the alcohol content reached 10% or over. After that the resultant was fermented to vinegar using the rapid-tray-culture method with appropriate ratio of nipa sap, nipa wine and vinegar starter. After fermentation for 7 days, the acetic acid was determined (AOAC 2000). The vinegar was then filtrated, pasteurized and hot-filled into a cleaned bottle. The acetic content of vinegar was adjusted to be 5.5% by adding water for further use.

3.2 Preparation of prototyped formulations

In this study, 4 formulations of vinegar drink were developed as follows:

3.2.1 Nipa sap formula

The nipa sap was prepared to have a desired TSS of 12°Brix and mixed with the nipa sap vinegar at a ratio of 1:12 (vinegar : nipa sap).

3.2.2 Butterfly pea formula

A number of dried butterfly peas was cleaned and soaked in boiling hot water for approximately 10 minutes. The flowers were taken off and the extract was mixed with honey and nipa sap vinegar at a ratio of 1:1.5:10.5 (vinegar : honey : butterfly pea extract).

3.2.3 Roselle-jujube formula

Equal amount of dried roselle and dried jujube (Chineses date) were cleaned and boiled together in hot water for approximately 10 minutes. The residues were taken off and the juice was mixed with honey and nipa sap vinegar at a ratio of 1:1.5:10.5 (vinegar : honey : roselle mixed with jujube).

3.2.4 Gac fruit formula

The pulp of ripe gac fruit was blended with boiled water at a ratio of 1:1. The mixture was heated at 65°C for 5 min and rapidly cooled down. The juice was kept frozen for further use. Before use, the gac fruit juice was diluted with boiled water at a ratio of 1:5. The formula for the vinegar drink consisted of nipa sap vinegar, honey and gac fruit juice at a ratio of 1:1.5:10.5, respectively.

3.3 Sensory Evaluation

Firstly, the prototyped vinegar drinks were evaluated using the just-about-right scales (JAR). The 50 panelists were asked to rate the level of color, sourness and sweetness whether the level is just right, or needed to be adjusted. The scales were decrease very much, decrease slightly, just right, increase slight and increase very much. The data were analyzed in terms of percentage and net effect. The cut-off point was set at 70% and the net effect was set at 20%.

After that, each prototype was adjusted to fit the consumer need according to the results from JAR. Then, the developed formulas were evaluated using 9-point Hedonic scale with 100 panelists. The scores ranged from 1 = dislike extremely to 9 = like extremely. The data were analyzed in terms of mean and standard deviation. The statistically significant difference at .05 level between the mean of each attribute was also investigated.

4. Research Results

Firstly, the 4 prototyped formulations of vinegar drink were prepared for sensory evaluation as shown in Figure 1.

Figure 1. The 4 prototyped formulations of vinegar drink nipa sap formula, butterfly pea formula, roselle-jujube formua and gac fruit formula

The 50 panelists were asked to rate the level of color intensity, sourness and sweetness whether the level is just right, or needed to be adjusted. The 5 scales were decrease very much, decrease slightly, just right, increase slight and increase very much. The percentage of response on JAR scales were shown in Table 1.

Table 1
The percentage of response on JAR scales

Attributes	Decrease		Just Right	Increase		Net effect
	very much	slightly		slightly	very much	
Nipa sap formula						
Color	0.0	0.0	100.0	0.0	0.0	-
Sweetness	0.0	4.0	74.0	16.0	6.0	-
Sourness	0.0	0.0	100.0	0.0	0.0	-
Butterfly pea formula						
Color	0.0	68.0	32.0	0.0	0.0	68.0
Sweetness	0.0	18.0	80.0	2.0	0.0	-
Sourness	0.0	0.0	100.0	0.0	0.0	-
Roselle-jujube formula Color	0.0	0.0	78.0	22.0	0.0	-
Sweetness	0.0	0.0	56.0	24.0	20.0	44.0
Sourness	0.0	12.0	88.0	0.0	0.0	-
Gac fruit formula						
Color	0.0	0.0	100.0	0.0	0.0	-
Sweetness	0.0	0.0	100.0	0.0	0.0	-
Sourness	0.0	0.0	100.0	0.0	0.0	-
Viscosity	0.0	0.0	100.0	0.0	0.0	-

The results from JAR testing revealed that the nipa sap formula was rated at just right 100% for both color and sourness. Although the sweetness was rated at just right for 74% but this percentage did not exceed the cut-off point (70%). Therefore, this formula did not have to be adjusted. In the same manner, all attributes of the gac fruit formula were rated as just right 100% indicating no need for formulation improvement.

For the butterfly pea formula, the color was rated at decrease slightly for 68% while the other attributes were at just right; 80% for sweetness and 100% for sourness. The change in this formula was performed by decrease the amount of dried flower soaked in boiling hot water from 15 grams in 1 liter water to 5 and 10 grams. The ratio of vinegar, honey and butterfly pea extract was still the same to maintain the taste of the product. Figure 2 indicated that the dark color turned slightly lighter with less dried flowers.

For the roselle-jujube formula, it was found that the sweetness of the product needed to increase as this attribute was rated 56% for just right, 24% for increase slightly and 20% for increase very much, respectively. Thus, the amount of honey was brought up from 1.5 to 2 and 2.5 portion in the formulation ratio. Meanwhile, the amount of roselle-jujube juice was decrease in accordance with the increase of honey to maintain the amount of vinegar in the formula since the sourness was rated at just right.

Figure 2. Three butterfly pea formulas from different ratio of dried flower in the extract (5, 10 and 15 grams in 1 liter water)

After formulation improvement according to the JAR result (Figure 3), each formula was sensory evaluated again using 9-point Hedonic scale with 100 panelists.

Figure 3. The developed formulations of vinegar drink after JAR testing From the left: nipa sap formula, butterfly pea formula 1 and 2, roselle-jujube formua 1 and 2, and gac fruit formula

Table 2 showed the mean and standard deviation of each attributes from sensory testing. The statistically significant difference between the mean of each attribute was performed within the same flavor only. To be exact, butterfly pea 1 was compared to butterfly pea 2 while roselle-jujube 1 was compared to roselle-jujube 2.

Table 2
Sensory evaluation of vinegar drinks using 9-point Hedonic scale

Formula	Attributes		
	Color	Taste	Overall acceptance
Nipa sap	7.34 ± 0.65	7.28 ± 0.88	7.45 ± 0.72
Butterfly pea 1 (5 g dried flower)	7.05 ± 0.72^{b}	7.58 ± 0.75^{ns}	7.50 ± 0.70^{b}
Butterfly pea 2 (10 g dried flower)	7.35 ± 0.66^{a}	7.60 ± 0.80^{ns}	7.71 ± 0.67^{a}
Roselle-jujube 1 (V:H:J = 1:2:10)	0.66 ± 7.45^{ns}	0.84 ± 7.69^{ns}	0.67 ± 7.82^{ns}
Roselle-jujube 2 (V:H:J = 1:2.5:9.5)	0.59 ± 7.49^{ns}	0.79 ± 7.76^{ns}	0.69 ± 7.88^{ns}
Gac fruit	0.59 ± 7.45	0.85 ± 7.61	0.79 ± 7.83

* The mean difference is significant at the .05 level.
V:H:J = vinegar : honey : juice

It was found that the nipa sap formula received liking scores at like moderately for all attributes. The butterfly pea formula 2 (10 g dried flower) got the significantly higher liking score on color and overall acceptance ($p<0.05$) than those of the formula 1 (5 g dried flower). While the scores on taste for both samples were at like very much. For the roselle-jujube formula, the change on honey amount in the formula caused no difference in liking scores on all attributes ($p>0.05$). Both ratios received liking scores at like moderately for color and like very much for taste and overall acceptance. The gac fruit formula also received liking scores at like moderately for color and like very much for taste and overall acceptance.

Table 3
The optimal formula of developed vinegar drinks

Formula	Ratio			Percentage		
	Nipa vinegar	Honey	Extract/ Juice	Nipa vinegar	Honey	Extract/ Juice
Nipa sap	1	-	12	7.69	-	92.31
Butterfly pea	1	1.5	10.5	7.69	11.54	80.77
Roselle-jujube	1	2	10	7.69	15.38	76.92
Gac fruit	1	1.5	10.5	7.69	11.54	80.77

The optimal formulation of each product after development could be concluded in Table 3. The nipa sap formula consisted of 7.69% vinegar and 92.31% nipa sap. The butterfly pea consisted of 7.69% vinegar, 11.54% honey and 80.77% butterfly pea extract. The roselle-jujube formula consisted of 7.69% vinegar, 15.38% honey and 76.92% roselle-jujube juice. Lastly, the gac fruit formula consisted of 7.69% vinegar, 11.54% honey and 80.77% gac fruit juice.

5. Discussion

The points to be discussed based on the results of this study are as follows:

5.1 During the JAR testing, it was found that many panelists expected the blue color of the butterfly pea formula while the products expressed dark violet due to the color change by acidic pH of the anthocyanin. Some comments were found that the panelists wanted more blue on the product color which was impossible. After discussion, they agreed to choose "decrease the color slightly" (68%).

5.2 In Table 1, the net effect was calculated by subtraction the smaller percentage on either changing direction from the higher percentage. For example, the net effect of the sweetness of the roselle-jujube formula was 44.0 getting form (24 +20) – (0+0). When the percentage at just right is lower that the cut-off point, the net effect will indicate the amount and changing direction for subsequent formula improvement. That is why the net value of sweetness nipa sap formula did not show in Table 1 since its just right was rated at 74% higher than the cut-off point specified in this study (70%).

5.3 From Table 2, the overall liking score of nipa sap formula was a bit lower than other formulas may be due to a trace of salty taste in the nipa sap. Since nipa palm grows in the mangrove forests, therefore, the nipa sap sometimes contains a hint of natural salty taste from the salty land. There were 2 panelists commented that the smell of the drink seemed like spoiled product. However, they gave the overall liking at 6 (like slightly) and 7 (like moderately) while the others gave the scores from 7 (like moderately) to 9 (like extremely) leading the mean scores for overall liking at 7.45 or like moderately.

5.4 At the same ratio of nipa palm vinegar, honey and extract or juice, the roselle-jujube formula was rated to increase the sweetness while other formulas were at just right. This can be explained by the effect of natural sour taste in the roselle juice. After formulation development, the higher honey ratio seemed to get higher liking scores for all attributes. However, the analysis of significant difference between the two formulas on every attribute indicated no statistically significant ($p<0.05$). Accordingly, the formula ratio at 1:2:10 was chosen due to economic reason.

6. Conclusion

The optimal nipa sap formula at a ratio of 1:12 received the overall acceptance score at like moderately (7.45 ± 0.72). It consisted of 7.69% vinegar and 92.31% nipa sap. The optimal butterfly pea formula at a ratio of 1:1.5:10.5 received the overall acceptance score at like very much (7.71 ± 0.67). This formula consisted of 7.69% vinegar, 11.54% honey and 80.77% butterfly pea extract. The optimal roselle-jujube formula received the overall acceptance score at like very much (0.67 ± 7.82). It was at a ratio of 1:2:10 and consisted of 7.69% vinegar, 15.38% honey and 76.92% roselle-jujube juice. The gac fruit formula

received the overall acceptance score at like very much (0.79 ± 7.83). The optimal formula was at a ratio of 1:1.5:10.5 and consisted of 7.69% vinegar, 11.54% honey and 80.77% gac fruit juice.

7. Recommendations

7.1 The results should be propagated to the community enterprises that have nipa palm forest nearby to encourage more utilization on local nipa palms. Moreover, the vinegar drink could be produced for both home use to promote health of family members and commercial as a community product.

7.2 The recommendations for further research are that the health benefit properties of the vinegar drink products should be studied and other kinds of vinegar drink products should also be developed.

7.3 The effect of heat treatment and storage condition on functional properties and phytonutrients of the vinegar drink products should be conducted.

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