

Utilization of Dates (*Phoenix dactylifera* L.) and Bilimbi (*Averrhoa bilimbi* L.) in Making Effervescent Tablet

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Abstract

Dates were fruits have many nutrients including minerals, vitamins and active compounds as antioxidants. Bilimbi contains vitamin C, minerals, amino acid. Dates were usually consumed directly without any processing, bilimbi could not be because the taste was too sour. The purpose of this research was to utilize dates juice and bilimbi juice in making effervescent tablets. The combination of dates and bilimbi will make the sour taste of bilimbi diminish because the sweetness of the dates which were natural sweetener. Making effervescent tablets began with making juices from dates and bilimbi fruits and then making juices powder by freeze drying method without addition of sugar. The ratio of dates: bilimbi juice powder were 9:1, 8:2, and 7:3 and sodium bicarbonate: citric acid: 1:1, 2:1 and 1:2. Effervescent tablet drinks were analyzed of its antioxidant activity (IC_{50}), hedonic, physicochemical analysis (pH, color, total titratable acid, total soluble solid). The best formulation was the ratio of dates: bilimbi juice powder 9:1 and sodium bicarbonate: citric acid 2:1 has IC_{50} 6.79%, phenolic 19.47 mg GAE /L, flavonoids 10.17 mg QE /L. The average overall hedonic results was 4.6 (scale of 1-7). Dates and bilimbi can be used as diversification of healthy food products in form effervescent tablets.

Keyword

Bilimbi, dates, effervescent tablet, freeze, drying.

1. Introduction

Dates (*Phoenix dactylifera* L.) were fruits that widely grown in the Middle East. Dates could grow in Asian such as Indonesia (Rahmadani, 2017). Dates contained 20-70% (dry basis) of simple sugars so they were easily digested and absorbed by the body (Retnowati and Kusnadi, 2014). Dates fruit also contains many active compounds that act as antioxidants like flavonoids, phenolic, vitamins and other active compounds (Onuh et al., 2012) and usually were consumed directly without any processing. Bilimbi (*Averrhoa bilimbi* Linn.) was one of the *Averrhoa* family species that was widely grown in Indonesia. Bilimbi fruit contained various minerals such as sodium, potassium, calcium, phosphorus, magnesium and vitamin C 24.87 mg /100 g (Dewi et al., 2014; Bhaskar and Shantaram, 2013). Bilimbi has a high moisture content 95.62% which caused a relatively short shelf life and also has a very sour taste that cannot be consumed directly (Muzaifa, 2018). Freeze drying was one of the drying methods that aims to protect sensitive compounds. The principle of a freeze drying was applied a sublimation phenomenon wherein the water in frozen material turns into steam without the melting process of material (Zea, et al., 2013). Effervescent tablet was a tablet which was made by compresses the active ingredient in the form of acid and bases source. If tablet was put into water, then there was a chemical reaction between the source of acid and base which will produce gas in the form of carbon dioxide which gives the effect of freshness because it produces carbonation so that it is favored by society (Deasy, 2003). The utilization of dates juice and bilimbi juice into effervescent tablets was one of the diversification of food products. The combination of dates juice in bilimbi juice will make the sour taste of bilimbi can be reduced by the sweet taste of dates which will become a natural sweetener, so that it does not require the addition of sugar in making effervescent tablets.

1.1 Objectives

The objectives of this research is to utilize two kinds of fruits, dates in the form of dates juice and juice from bilimbi fruits in making effervescent tablets as the healthy drinks. This diversification of food product can extend the shelf life of the fruits especially bilimbi fruits.

The specific objectives of this research are as follows.

1. Making dates juice and bilimbi juice.
2. Analyzing antioxidant activity based on IC₅₀ value, phenolic, flavonoid and vitamin C in dates and bilimbi juice.
3. Making a combination of dates juice and bilimbi juice with a ratio of 9:1, 8:2 and 7:3 which is used as a powder as the main ingredient of effervescent tablets.
4. Making powder from dates juice and bilimbi juice using the freeze drying method.
5. Determine the best formulation of the ratio of dates juice and bilimbi juice as well as the ratio of sodium bicarbonate and citric acid in effervescent tablets

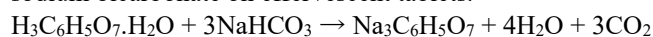
2. Literature Review

Dates are one of the fruits that have a high nutritional content. Dates have about 45% reducing sugar and about 7% non-reducing sugar. The sugars contained in dates are easily digested and absorbed into the blood after consumption and can be metabolized quickly to release energy that is useful for cellular activities (El-Sohaimy and Hafez, 2010). In addition, dates also contain many active compounds of alkaloids, flavonoids, steroids, tannins, phenolic acids and several enzymes. The content of flavonoids, total phenolics, and vitamins in dates can cause antioxidant activity by binding to free radicals (Onuh, et al., 2012).

Averrhoa bilimbi Linn. is a species of the starfruit family, namely Averrhoa. Many starfruits are found in Indonesia. The bilimbi plant has a tree trunk with a diameter of about 30 cm and a height of up to 15 m. This plant usually grows in the lowlands up to 500 m above sea level (Alhassan and Qamar, 2016). Bilimbi contains a lot of natural vitamin C, as much as 24.87 mg/100 g which can act as an antioxidant (Dewi, et al., 2014). In addition, bilimbi contains 18% ascorbic acid, 2% sugar, and 1% oxalate compounds. Bilimbi also has a high mineral content such as sodium, potassium, calcium phosphorus, magnesium, iron, copper, zinc and manganese (Bhaskar and Shantaram, 2013).

Freeze drying was one of the drying method that aims to protect sensitive components such as vitamin C, phenolic and flavonoid components, biological activity, appearance, color, texture, aroma and nutritional value. The principle of the freeze-drying methods applied the phenomenon of sublimation where the water in the frozen material turns into steam without any thawing process. Water sublimation will occur when the pressure is 4.579 mmHg and the temperature is 0.0099 °C (Zea et al., 2013).

Effervescent tablet was a tablet that was made by compressing the active ingredients in the form of acid and base sources. When these tablets were put into water, a chemical reaction occurs between the acid and base sources which will produce gas in the form of carbon dioxide. Effervescent tablets have the advantage that they are more physically and chemically stable, do not agglomerate and harden quickly when compared to powder or powder forms. In addition, effervescent tablets were also very practical and provide a freshness effect because they produce carbonation so that they were favored by the public (Deasy, 2003). The following is the reaction of citric acid and sodium bicarbonate on effervescent tablets.



Citric acid Na-bicarbonate Na-citric water carbon dioxide

3. Methods

Dates and Bilimbi Juice Powder Making

The process of making powder from dates and bilimbi juice began with making juice from each ingredient. Dates were peeled, so the seed and the dates were separated. Dates meat was reduced in size by cutting using a knife, then put into a blender and added water with a ratio of 3: 2 (water: dates). Dates that have been crushed will be filtered using a filter cloth to get dates juice. Bilimbi were sorted by size with a length of about 5.5 cm, and washed with running water. Bilimbi was crushed with a blender and filtered to obtain the juice. Each juice was analyzed by its antioxidant activity IC₅₀, phenolic, flavonoids and vitamin C. Dates and bilimbi juice that has been obtained will be mixed with three different ratio with a ratio of dates juice: bilimbi juice 9: 1, 8: 2 and 7: 3 (w/w) and dried with a freeze dryer. The procedure for making dates and bilimbi juice into powder can be seen in Figure 1.

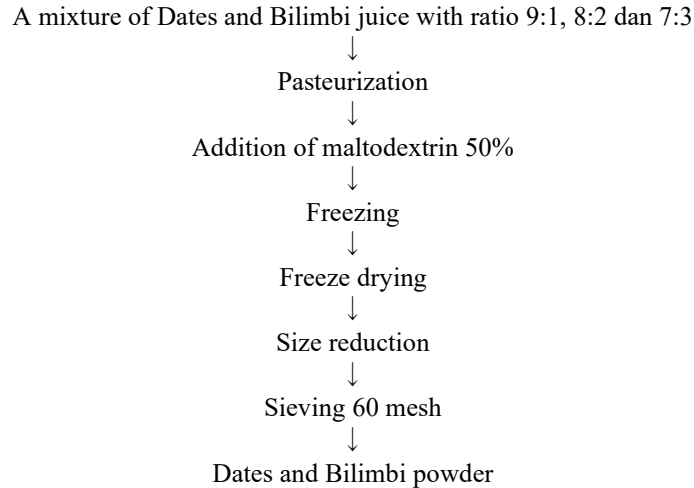


Figure 1. Procedure for making dates and bilimbi juice into powder
 Source: Modified from Caliskan, et al. (2015); Dewi, et al. (2014) modified.

Effervescent Tablets Making

The main research aims to determine the effervescent tablets formulation with ratio of dates juice and bilimbi juice 9: 1, 8: 2, 7: 3 and sodium bicarbonate: citric acid with ratio 1: 1, 2: 1 and 1: 1. Effervescent tablets with a weight of 2.5 g and dissolved in 33ml water. Selected effervescent drinks were analyzed for proximate analysis. The results of the effervescent tablets formulation could be seen in Table 1.

Table 1. Formulation of Effervescent Tablet

Formulation	Ratio Dates: Bilimbi powder	Date and Bilimbi powder (g)	Sodium Bicarbonate (g)	Citric Acid (g)	Total (g)
F1	9:1	63.4	18.30	18.30	100
F2		63.4	27.45	9.15	100
F3		63.4	9.15	27.45	100
F4	8:2	63.4	18,3	18.30	100
F5		63.4	27.45	9.15	100
F6		63.4	9.15	27.45	100
F7	7:3	63.4	18.30	18.30	100
F8		63.4	27.45	9.15	100
F9		63.4	9.15	27.45	100

Source: Modified from Tampubolon dan Yunianta (2017)

Effervescent drinks were analyzed for chemical, physical and organoleptics. Chemical analysis parameters include proximate analysis, pH values, total titrated acid, vitamin C, antioxidant activity, total flavonoids and total phenolic, total dissolved solids, dissolution time and water solubility test. Organoleptic tests include scoring and hedonic tests.

4. Data Collection

Antioxidant Activity of Dates Juice and Bilimbi Juice

Juice of dates and bilimbi were analyzed for antioxidant activity, total phenolic, flavonoids and vitamin C. The antioxidant activity (IC_{50}) in dates juice $1.24 \pm 0.08\%$ and bilimbi juice was $2.12 \pm 0.02\%$. This antioxidant activity both in dates juice and bilimbi juice were categorized as having very weak antioxidant activity, because IC_{50} value above 200 ppm. According to Karadeniz (2005), antioxidant activity could be categorized into 5 (five) types based on IC_{50} values which was very strong (<50 ppm), strong (50-100 ppm), medium (100-150 ppm), weak (150-200

ppm) and very weak (> 200 ppm). on Total phenolic in dates juice and bilimbi juice was 22.85 ± 0.20 mg GAE / g and 8.33 ± 0.04 mg GAE / g. Total flavonoid 9.01 ± 0.07 mg QE /g and 4.98 ± 0.02 mg QE / g respectively. Vitamin C in dates juice and bilimbi juice was 6.76 ± 0.04 ppm and 30.43 ± 0.28 ppm respectively.

Moisture Content of Dates Juice Powder and Bilimbi Juice Powder

The results of statistical analysis of SPSS one way ANOVA of moisture content from effervescent tablets, are showed that the ratio of each dates: bilimbi powder was not significant different ($p \geq 0.05$).

Table 2. Moisture content of Dates Juice Powder and Bilimbi Juice Powder

Date: Bilimbi	Moisture Content (%)
9:1	8.29 ± 0.29
8:2	8.38 ± 0.40
7:3	8.55 ± 0.30

The addition of maltodextrin into the juice increased the amount of dissolved solids, so that the water in the juice to be evaporated was reduced and the value of the water content of the powder becomes smaller (Srihari, 2010)

5. Results and Discussion

5.1 Numerical Results

Effect of Ratio Dates: Bilimbi Juice Powder and Sodium Bicarbonate: Citric acid Toward Antioxidant Activity (IC_{50}) and Total Phenolic of Effervescent Tablet Drinks

Based on the statistical analysis of SPSS univariate ANOVA, the antioxidant activity in effervescent tablet drinks showed that the ratio of Dates: Bilimbi juice powder, sodium bicarbonate: citric acid and the interaction of both had a significantly difference ($p < 0.05$). It can be seen at Figure 2.

The lowest IC_{50} value of effervescent tablets drink was ratio of Dates and Bilimbi juice powder 9: 1 with a ratio of sodium bicarbonate and citric acid 1: 2 was 6.79%, while the highest was Dates and Bilimbi juice powder 7: 3 with the ratio of sodium bicarbonate and citric acid 2: 1 which was 13.06%. The IC_{50} value was inversely correlated with antioxidant activity where IC_{50} values was low, so that antioxidant activity was high (Sebaugh, 2010). The ratio of Dates juice in the formulation affects the value of IC_{50} , the more dates ratio have lower the IC_{50} value. This was because IC_{50} of dates juice was 1,22%, so effervescent tablets with a smaller ratio of dates juice show higher IC_{50} . Addition higher of citric acid will reduce the IC_{50} value. Citric acid is one of the secondary antioxidants that is often added to create a combination with primary antioxidants. This combination will provide a synergistic effect so that the work of primary antioxidants is more effective. Synergistic relationship between citric acid and polyphenols because citric acid is chelating so that it can bind metals that oxidize polyphenolic compounds (Rosida et al., 2017). Effervescent tablets drink with ratio Dates and Bilimbi juice powder 9: 1 and ratio of sodium bicarbonate and citric acid 1: 2 has the highest total phenolic content of 18.47 mg GAE /L while the lowest is 4.03 mg GAE / L with ratio Dates and Bilimbi juice powder 7:3 with a ratio of sodium bicarbonate and citric acid 2:1. The greater the ratio of dates in powder, the greater the total phenolic value. Addition of citric acid will have a synergistic effect on date polyphenols and Bilimbi. Citric acid is a chelating that works to bind metals that can oxidize polyphenol compounds so that the oxidation of polyphenol compounds can be reduced. Chelating is binding to metals which can accelerate oxidation reactions (Kumalaningsih, 2006).

Effect of Ratio Dates: Bilimbi Juice Powder and Sodium Bicarbonate: Citric acid Toward Total Flavonoid and Vitamin C of Effervescent Tablet Drinks

The results of statistical analysis of total flavonoid SPSS univariate ANOVA in effervescent tablet drinks showed that the ratio of Dates: Bilimbi juice powder, sodium bicarbonate: citric acid and their interaction of total flavonoid and vitamin C had a significantly difference with $p < 0.05$. It can be seen in Figure 3.

The results showed that effervescent tablet drinks with the ratio Dates and Bilimbi juice powder 9: 1 with a ratio of sodium bicarbonate and citric acid 1: 2 had the highest total flavonoid content of 11.17 mg QE /L, and the lowest was 2.85 mg QE /L with a ratio Dates and Bilimbi juice powder 7:3 and ratio of sodium bicarbonate and citric acid

2:1. The greater the ratio of Dates in powder, the greater the total flavonoid value on effervescent tablet drink. Flavonoids can act as antioxidants by donating H + atoms in the form of glucosides or free / aglycone (Redha, 2010). Total flavonoids are directly proportional to antioxidant activity and total phenolic. The value of IC50 is inversely proportional to the value of total phenolic, flavonoids and antioxidant activity. Flavonoids can act as antioxidants by donating H + atoms in the form of glucosides.

Based on the results of statistical analysis of SPSS univariate ANOVA vitamin C in effervescent tablet drinks, it was shown that the ratio of Dates: Bilimbi juice powder, sodium bicarbonate: citric acid and their interaction had a significantly difference with p value <0.05 on vitamin C effervescent tablet drinks.

Effervescent tablet drinks with a ratio of Dates:Bilimbi juice powder 7:3 and ratio sodium bicarbonate: citric acid 1: 2 has the highest vitamin C content 35.19 ppm while the lowest level is 21.11 ppm with a ratio Dates: Bilimbi juice powder 9: 1 and the ratio of sodium bicarbonate: citric acid 2: 1. The greater the ratio of Bilimbi in effervescent tablets, greater value of vitamin C. Bilimbi has a vitamin C content of 24. 87 mg /100 g (Dewi, et al., 2014). Bilimbi also has various active compounds such as amino acids, flavonoids, tannins, essential oils, valepotriates, coumarins, and terpenes. The fruit is also rich in vitamin C and oxalic acid (Hassanuzzaman, et al., 2013).

pH Value

Effervescent tablet drinks with ratio of Dates: Bilimbi juice powder 9: 1 and ratio sodium bicarbonate: citric acid 2: 1 has the highest pH value of 8. 46 while the lowest in effervescent tablet drinks is 4.11 with a ratio of Dates: Bilimbi juice powder 7: 3 and the ratio of sodium bicarbonate: citric acid 1: 2. Bilimbi has a sour taste that comes from organic acids such as ascorbic acid, citric acid and other organic acids which cause the pH value to be low (Hassanuzzaman, et al., 2013). Addition of citric acid can also cause the pH value to be lower.

Titrateable Acidity

Effervescent tablet drinks with a ratio of Dates: Bilimbi juice powder 7: 3 and the ratio of sodium bicarbonate: citric acid 1: 2 has the highest total titration acid value, 0.91 g citric acid / 100 mL while the lowest is 0. 03 g citric acid / 100 mL with a ratio of Dates: Bilimbi juice powder 9: 1 and sodium bicarbonate ratio: citric acid 2: 1. This shows that the more concentrations of Bilimbi are added, total value of the titrated acid lower. The pH value and the total titrated acid are inversely proportional to the fact that the acidic drink has a low pH value (acid) and the higher the titrated acid. The value of pH to measure the concentration of free hydrogen ions, while the total titrated acid is the concentration of acid in the sample (Nielsen, 2017).

Total Dissolved Solid

Effervescent tablet drink with ratio of Dates: Bilimbi juice powder 9: 1 and the ratio of sodium bicarbonate: citric acid 1: 2 has the highest total dissolved solid value of 6.43. The amount of Dates in the powder affects the total amount of dissolved solids because the more the number of Dates is added, the more sugar is also present in the drink. Dates have a lot of reducing and non-reducing sugars. The large amount of sodium bicarbonate can reduce the total value of dissolved solids because sodium bicarbonate reduces the acidity of effervescent drinks. Addition of citric acid in large quantities can increase the value of dissolved solids because citric acid has a higher solubility (Tampubolon and Yunianta 2017). The increase in the total value of dissolved solids occurs because of the termination of long chains of carbohydrate compounds which can be caused by acids so that they become soluble sugar compounds and the total value of dissolved solids increases. (Anesakirani, et al., 2018).

Dissolved Time and Solubility

Dissolved Time

The results of statistical analysis of SPSS univariate ANOVA effervescent tablet shows that the ratio of Dates: Bilimbi juice powder has no significantly difference with p value ≥ 0.05 on dissolved time, while the ratio of sodium bicarbonate: citric acid has a significantly difference with p <0, 05 to the time value of dissolving effervescent tablet drinks. The results showed that effervescent tablets had a dissolution time of less than three minutes, namely 75-162 seconds so that all treatments met the standard dissolved time. According to Anshory, et al. (2007), good effervescent dispersion time is less than 5 minutes because if more then the effervescent quality is not good. Formulation with ratio sodium bicarbonate: citric acid 2: 1 faster than 1: 2. The higher amount of sodium bicarbonate will produce a relatively shorter dissolution time because sodium bicarbonate is a crushing agent when reacting with acid. The addition of sodium bicarbonate and citric acid with a balanced ratio of 1: 1 results in the fastest dissolution time. It can be seen in Figure 4. Dissolved Time of effervescent tablet drinks

The results of the statistical analysis of SPSS univariate ANOVA on solubility of effervescent tablets showed that the ratio of Dates: Bilimbi juice powder and sodium bicarbonate: citric acid was not significant different from the values of $p \geq 0.05$. Solubility is strongly influenced by water-soluble ingredients such as maltodextrin and citric acid. Sodium bicarbonate has an important role in the solubility of effervescent tablets because this material can produce CO₂ gas as the crushing agent of the material that fills effervescent tablets. The CO₂ gas produced can help dissolve effervescent tablets without stirring provided that the material used is very soluble in water (Fung and King, 2003). Based on the results of the study, effervescent tablets have water solubility of around 99% where high solubility shows good quality on the product because the serving process easier.

Table 3. Solubility of effervescent tablets

Dates : Bilimbi	Sodium bicarbonate: citric acid	Solubility
9:1	1:1	99.87±0.01
	2:1	99.88±0.00
	1:2	99.89±0.00
8:2	1:1	99.86±0.00
	2:1	99.84±0.01
	1:2	99.85±0.02
7:3	1:1	99.86±0.03
	2:1	99.87±0.00
	1:2	99.88±0.02

Foam Volume

Results of univariate ANOVA SPSS statistical analysis foam volume of effervescent tablets showed that the ratio of Dates: Bilimbi juice powder no significant different $p \geq 0.05$, whereas the ratio of sodium bicarbonate: citric acid have a significantly difference with $p < 0.05$. Based on the results of the study, the effervescent tablet drink which had the highest volume of foam was 31.67% with a ratio of sodium bicarbonate: citric acid 2: 1 as the lowest was 13.98 % with a ratio of sodium bicarbonate: citric acid 1: 2. The amount of sodium bicarbonate added is high, so the production of CO₂ gas increases and the volume of foam produced is also higher. Another factor can affect the volume of foam is pressure when an effervescent tablet is inserted into the water. The greater the pressure on the tablet, the greater the volume of foam produced (Amelia, 2015). It can be seen in Figure 5. Dissolved Time of effervescent tablet drinks

Overall Hedonic Test

The results of the SPSS univariate ANOVA statistical analysis of the overall hedonic test on effervescent tablet drinks showed that the ratio of Dates: Bilimbi juice powder and sodium bicarbonate: citric acid had a significantly difference with $p < 0.05$. Interaction between ratio Dates: Bilimbi juice powder and sodium bicarbonate: citric acid had no significantly difference with $p \geq 0.05$ value.

Selected Effervescent Tablet Drinks

Determination of effervescent tablet drink formulations based on IC₅₀ values, total phenolic and flavonoids. The selected formulation from this research was formulation with ratio Dates and Bilimbi juice powder of 9: 1 and sodium bicarbonate: citric acid 2: 1. This formulation has IC₅₀ 6.79%, total phenolic 19.47 mg GAE / L, flavonoid 10.17 mg QE / L, Vitamin C 30.07 ppm, pH 4.34, total titrated acid 0.66 g acid citrate / 100 mL, total dissolved solids 6.43 and solubility of 99.89 %. The average hedonic value of total was 4.6 (neutral-rather like) on a scale of 1-7. The selected drinks formulation has water content of 94.43%, ash 0.25%, protein 0.08%, fat 0.10% and carbohydrate 5.12%.

5.2 Graphical Results

Add graphical results here. Make sure to describe all figures and add inferences. If needed, add statistical analysis here.

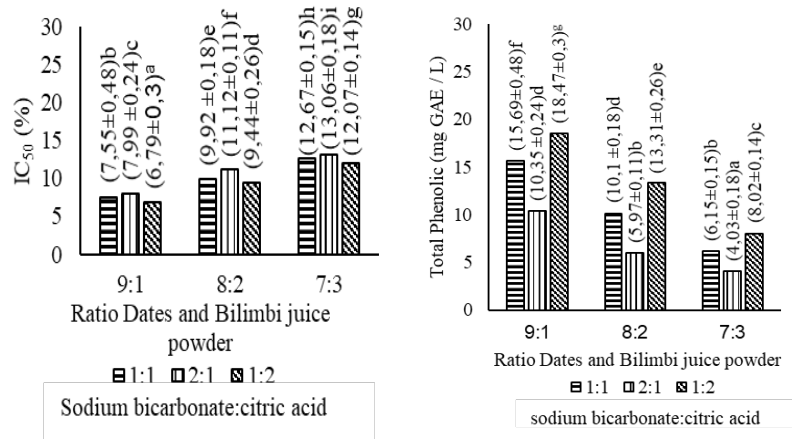


Figure 2. IC₅₀ and Total Phenolic of Effervescent tablet drinks ,Notes: Different superscript letter notations indicate a significant difference (p<0.05)

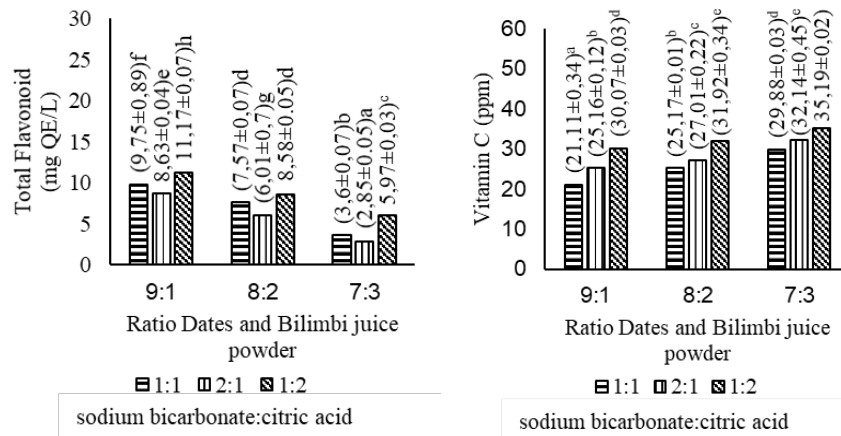


Figure 3. Total flavonoid and Vitamin C of effervescent tablet drinks , Notes: Different superscript letter notations indicate a significant difference (p<0.05)

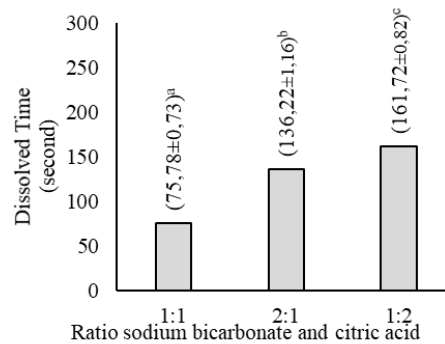


Figure 4. Dissolved Time of effervescent tablet drinks .Notes: Different superscript letter notations indicate a significant difference ($p<0.05$)

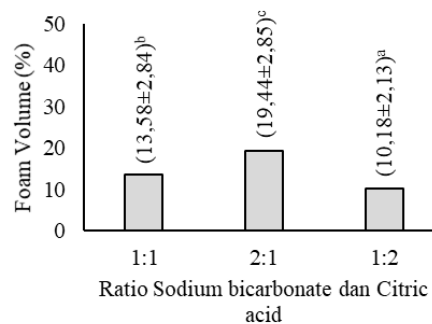


Figure 5. Dissolved Time of effervescent tablet drinks .Notes: Different superscript letter notations indicate a significant difference ($p<0.05$)

6. Conclusion

Making effervescent tablets from dates and bilimbi fruits is a form of food diversification. Dates in effervescent tablets reduced the sour taste in bilimbi with sweet taste in dates which acts as a natural sweetener, so it did not require the addition of sugar in making effervescent tablets. The effervescent tablet drinks with a ratio of dates powder 9 : bilimbi powder 1 and sodium bicarbonate 2: citric acid 1, was the best formulation based on antioxidant activity IC50, total phenolic and flavonoid. The average overall hedonic test score is 4.6 (neutral-slightly like) from a scale of 1-7, including quite liked by respondents. Further research is needed to increase the antioxidant activity of the dates and bilimbi (i.e by maceration). It is also necessary to investigate the effect of pressure in making tablet by Freeze Dryer on the characteristics of effervescent tablet drinks. It is necessary to add an antifoam agent as food additive to reduce the formation of foam not too much in effervescent tablet drinks

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Biography

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