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The Improvement Lycopene Availability and Antioxidant Activities of Tomato (*Lycopersicum esculentum*, Mill) Jelly Drink

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Abstract

Lycopene is a natural compound that is found in large quantities in red colour fruits, especially in tomatoes. Availability of lycopene in tomatoes will increase after processing. The research, tomatoes will be processed in form of jelly drinks, where most people like the products beside energy contributor. Fresh tomato fruit has a distinctive odor that is less preferred, it is to improve the flavor of products needs to be given the addition of other fruits, one of which is a lemon. The addition of lemon juice can also increase the antioxidant activity of the product as a lemon jelly drinks rich in vitamin C. The treatment in this study was the level of the additional of lemon juice with different concentrations. The results showed elevated levels of lycopene in jelly beverage products as much as two times higher than fresh tomatoes, the additional of lemon juice can increase antioxidant activity, vitamin C and total acid, but did not affect the levels of lycopene.

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Keywords: lycopene, antioxidants, tomato, lemon, jelly drinks.

1. Introduction

Tomato (*Lycopersicum esculentum*, Mill) is a plant that very well known by the public and quite high production and distribution in Indonesia. Compounds in tomatoes (*L. esculentum*, Mill) among solanine, saponins, folic acid, malic acid, citric acid, bioflavonoids (including lycopene, α and ß-carotene), proteins, fats, vitamins, minerals and histamine (Canene-Adam et al., 2005). Lycopene is one of the most widely chemical content in tomatoes, 100 grams

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of tomatoes on average contain as much as 3-5 mg lycopene (Giovannucci, 1999). Some studies suggest that tomatoes can be useful as a drug diarrhea, gall attack, indigestion and restore liver function (Fuhramn, 1997).

According to (Allen et al., 2002), lycopene is not synthesized in the human body but fluctuations in the presence of serum greatly affects human health. Several in vitro studies found that lycopene has potent antioxidant activity. Levy et al. (1995) mention that lycopene is able to inhibit the growth of endometrial cancer, breast cancer and lung cancer in cell cultures with higher activity than the α and β-carotene. Lycopene is found able to inactivate free radicals and inhibiting compounds of hydrogen peroxide and nitrogen peroxide (Bohm et al., 1995). Naturally lycopene in plants is in the form of the trans configuration are thermodynamically stable form (Nguyen and Schwartz, 1999). With the warming effect can be turned into a form of trans isomers cis mono or poly (Sudardjat and Gunawan, 2003). In general, the cis isomer is more polar, have a lower tendency to be crystalline, more soluble in oil and a hydrocarbon solvent, it is easier to join the lipoprotein or the structure of lipid subcellular, making it easier to enter the cell and are less stable than trans isomer (Clinton et al, 1996). It is therefore necessary to streamline product innovation for the public consumption of lycopene. The results showing that consumption of tomato sauce more effective to improving bioavailability of lycopene in the body than eating fresh tomatoes. Furthermore Allen et al. (2003) states Lycopene is found in the mucosal cells in larger quantities in individuals who consume tomato sauce. It shows that the presence of lycopene increase in processed tomato products than in fresh tomatoes.

One of the product innovations of processed tomato is beverage of jelly. Beverage product of jelly to have the character of elastic with soft gel consistency so that easily to drink. This beverage can eliminate thirst overcome to feel hungry. Beverage product of jelly consumed by inhaled and direct swallowed. Making of beverage of jelly with high viscosity especially from acidulous fruit and pectin, and also addition of sugar, water and a thickener. Problem of processing of tomato become beverage is less tomato flavor taken a fancy, because tomato contain of terpenoides compound so that there no unpleasant odor (Kartika, 2014). One of the efforts is additional of lemon juice. Lemon juice is rich in antioxidants vitamin C, but it also contains vitamins B, E, sodium, and some micro minerals needed by the body for the immune system and prevents the virus that causes influenza. Lemon is also loaded with bioflavanoid content acts as an antioxidant and fiber content in the form of pectin is good for lowering cholesterol and triglycerides (Sarwono, 1991). Therefore, this study aims to determine the effect of additional of lemon juice to improve the taste and the antioxidant activity of tomato jelly beverage products in an effort to increase the availability of lycopene in the body.

2. Research Method

2.1. Material

Materials used in this study were a red tomatoes, lemon, sugarcane, gel-forming materials. Chemicals used were Iod, starch indicator, KCl, HCl, H_2SO_4, NaOH, K_2SO_4, alcohol 96%, hexane, acetone, ethanol, and 2,2-diphenyl-1-picrylhydrazyl (DPPH). The equipment used are analytical balance, stainless steel blade, pan, stainless steel spoon, vessel for cooking, spoon stirrer, a washcloth, a stove, a plastic cup jelly drinks, and others. Tool to analyze is the UV-VIS spectrophotometer, analytical balance, erlenmeyer, measuring cups, beaker glass, burettes, filter paper, funnel glass, flask, oven, filter paper, pipette, cup aluminum, pH meter, viscometer, hand refractometer, etc.

2.2. Research design

The study design was completely randomized design (CRD) with 5 treatment and 3 replications. The data obtained were analyzed using analysis of variance with F test and Duncan's New Multiple Range Test (DNMRT) at 5%. The treatment in this study is additional rate of lemon juice with the treatment as follows: A (without lemon); B (2.8%); C (5.6%); D (8.4%) and E (11.2%).

2.3. Making of jelly drink

Fresh red tomatoes are heated with steam at a temperature of 85℃ for 10 minutes, then crushed and filtered. To obtain tomato juice, then the tomato juice added water so that the final volume to three times its original liquid. Then added sugar and plain nutrijel, and heated at 90℃ for 10 minutes. Last added lemon juice according to treatment and jelly drink that was obtained as soon cooled and inserted into the cup lid.

2.4. Determine the physical and chemical properties

Determine the physical and chemical properties on tomato jelly drink product is a total acid, dissolved solids, pH, vitamin C, viscosity, and sensory assessment that includes the color, flavor, aroma, and consistency.

2.5. Determination of lycopene (Sharma and Le Maguer, 1996)

Weighed 5 grams of sample drinks tomato jelly, inserted into the erlenmeyer lid lined with aluminum foil on the outside and protected from light. Add 50 ml of solution (hexane: acetone: ethanol = 2: 1: 1) v / v, shaken for 30 minutes with a magnetic stirrer, then separated to funnel separate, then add 10 ml of distilled water, then shaken again for 15 minutes. Separate the layers of polar and non-polar layer, grab all of the top layer (non-polar) enter in a 100 ml measuring flask, add an organic solvent to mark boundaries. Determine the total lycopene content of non-polar layer (top) with UV-Vis spectrophotometer at a wavelength of 417 nm maximum. Calculation levels of lycopene are.

$$C = \frac{A}{E^{1\%}_{1\,cm}\ x\ b}$$

Description:
C = concentration (g / 100 ml)
A = absorbance b = thick cuvette (cm)
$E^{1\%}_{1\,cm} = 3450$

2.6. Antioxidant activity with DPPH (Okawa et al., 2001)

100 mL sample inserted into test tubes containing 3 ml of ethanol was 96% and divortex. Add 1 ml of DPPH in ethanol and in the vortex. Left for 30 minutes in a dark room at room temperature. Λ measured absorbance at 517 nm. Blanko are made by the same procedure, the sample was replaced with deionized distilled water. The inhibitory activity was calculated according to the equation:

The inhibitory activity (%) = [1- (A-sample / A-control)] x 100%.

3. Result and Discussion

3.1. The physical and chemical properties

Determination of physical and chemical nature conducted on viscosity, acidity (pH), total acid, vitamin C, total soluble solids, lycopene content and antioxidant activity. The average results of the analysis are presented in Table 1 and Table 2. The result of statistical analysis is shown in Table 1, each treatment showing significant differences.

3.1.1. Viscosity

Viscosity is a measure that states the thick of a liquid or fluid. Viscosity is the nature of the fluid that is closely related with the obstacles to flow, like a liquid flowing in a rapid, water, alcohol, and gasoline. And the liquid flows slowly like glycerin and honey because the viscosity is great, so no other viscosity determines the speed of the flow of a fluid (Rao and Rizvi, 1995; Ahmad, 2007). The results showed that the additional of lemon juice giving significant effect (α = 5%) of the total value of viscosity, the higher the concentration of lemon juice then the lower the viscosity. This is due addition of lemon juice can increase or decrease the acidity of pH. The acidity of a product can reduce the viscosity, due happen sugar hydrolysis process by acid, so jelly formation more liquid. Furthermore, according to Desrosier (2008) that the formation of a gel (hydrocolloid) is affected by sugar, gelling materials, temperature, heating time and pH.

Table 1. Average of Analysis Physicochemical Nature Tomato Jelly Drink treatment with the additional of lemon juice

Addititonal lemon juice	Viscosity (DPS)	PH	Total Acid (%)	VitaminC (mg / 100 g of material)	Total Dissolved Solids (^{0} **Brix)**
A = 0	4.16 ± 0.13 d	4.72 ± 0.24 d	0.29 ± 0,04a	9.51 ± 2.073 A	16.56 ± 0.20 b
B = 2.8%	3.78 ± 0.06 c	4:28 ± 0.20 c	0.32 ± 0,01a	11.15 ± 1.353 ab	16.48 ± 0.10 b
C = 5.6%	3.71 ± 0.03 c	3.82 ± 0.02 b	0.46 ± 0.03 b	13.17 ± 0.569 b	16.06 ± 0,02a
D = 8.4%	3.46 ± 0.06 b	3.60 ± 0.03 b	0.60 ± 0.09 c	15.51 ± 0.821 c	15.96 ± 0,10a
E = 11.2%	3.23 ± 0,12a	3:23 ± 0,10a	0.72 ± 0.02 d	17.70 ± 0.372 d	15.86 ± 0,02a

* Data ± standard deviation
Figures followed by the same lowercase, not significantly different at the 5% significance level

3.1.2. Acidity (pH)

The degree of acidity (pH) in jelly products affected the texture, taste, flavor and color of the resulting product. Gels formed at low pH is more soft and thin, making it suitable for beverage products, as well as natural pigments such as anthocyanins, beta-carotene and lycopene to be stable at low pH (Desrosier, 2008). According Elistiasih and Ahmadi. (2009), in make of jelly drink, pH very affects to gel formation, it is because if the pH is too high, it causes rigidity to gel, whereas if the pH is too low cause syneresis. Syneresis the discharge of water from the gel, so the gel strength will be reduced even not forming be totally gel then drinks too thin. Total acid value is inverse of acid pH, higher total acid is lower pH. Increased total acid is affected by the addition of lemon juice in making of tomato jelly drink. Addition lemon juice can contribute to increasing taste, improving gelling and stabilizing the natural color of the resulting product. According to Snyder. (2009), main organic acids contained in fruit juice is citric acid and mallic acid. The element that causes a sour taste is the H + ions .Ion H^+ can be derived from an organic acid molecules which are found mainly in lemon and ionized molecule releases its proton H^{+}. More higher presence of H, more acid solution and lower pH.

3.1.3. Vitamin C

Additional of lemon juice can increasing vitamin C content of the jelly drink, but when compared with lemon and fresh tomatoes, vitamin C content of this very low. This is because vitamin C is very easily oxidized when processing, so amount in the processed products are much smaller than the levels in fresh material before cooked. Young tomatoes contain vitamin C of 30 (mg / 100 g material) and ripe tomatoes of 34 (mg / 100 g material). Lemon juice contains vitamin C of 50 (mg / 100 g material) (Moelyi, 2012).

3.1.4. Dissolved Solids

Total dissolved solids are dissolved materials in water that is not filtered by millipore filter paper with a pore size of 0.45 μm. These solids consist of inorganic compounds and organic dissolved in water, minerals and salts

contained in a solution (Anonymous, 2010). Analysis of variance of total dissolved solids each treatment showed significant differences (α = 5%). The value of total dissolved solids of tomato jelly beverage in this study ranged from 15.86 to 16.52 ^{0}Brix, the higher the concentration the addition of lemon juice, the total dissolved solids in the lower tomato jelly drinks. This is due to the addition of lemon juice will increase the acid in beverages jelly. Total dissolved solids associated with sugar content. According to Winarno (2008) that acid cause the hydrolysis of sucrose into glucose and fructose, excelsior of sucrose which was hydrolysis hence totalizing dissolve solid progressively lower.

3.2. Lycopene levels

Lycopene tomato jelly beverage and antioxidant activity can be seen in Table 2. The concentration of lycopene in jelly beverage products increased approximately two times higher than fresh tomatoes in mg/100 g of each ingredient. Similarly the addition of lemon juice can increase antioxidant activity in beverages jelly produced.

Lycopene is a carotenoid substance obtained in high concentration in tomatoes and is a powerful antioxidant. Heating or cooking tomatoes and processed tomato products may increase the bioavailability of lycopene from heat converts trans isomers into cis isomers. Lycopene in the cis form has a higher bioavailability than the lycopene in the transform (Agarwal, 2001). The results of the analysis of fresh tomato lycopene obtained 8.98 (mg/100 g). After processed into beverage products of tomato jelly, increased levels of lycopene into a 18:32 - 18.76 mg /100g. This is because the heating process can increase the levels of lycopene, if the heating temperature is too high will result in loss of lycopene (Shi and Maguer, 2000). According to Maulida (2010) that the optimum temperature during the heating of lycopene is 70° C. Furthermore, during processing, temperature and mechanical influence will weaken the strength of the bond between lycopene and tissue matrix, as well as facilitate breaking the cell walls so that the release of lycopene will increase lycopene in processed tomato products (Stahl and Sies, 1992).

Table 2. Average levels of Lycopene and Antioxidant Activity of Tomato Jelly Drink

Additional of lemon juice	Lycopene levels (mg / 100g)	Activity Antioxidants (%)
A = 0	18.60	24.55
B = 2.8%	18.76	33.91
C = 5.6%	18.72	39.51
D = 8.4%	18.76	47.54
E = 11.2%	18.32	54.59

3.3. Antioxidant Activity

Antioxidant activity analysis result of tomato jelly drinks showed an increase in line with an increase in amount of lemon juice added. According to Moelyi (2012) that lemon juice contains vitamin C which is higher than other citrus fruits. As is known, Vitamin C containing very high antioxidant activity, so more higher amount of lemon juice added, then antioxidant activity jelly beverage products also higher (Fig 1.). The amount of antioxidant activity is characterized by IC 50 value, is the sample solution concentration required to inhibit 50% of DPPH free radicals. Andayani (2008) research results, in testing of antioxidant activity using DPPH method to extract methanol tomatoes obtained IC 50 of 44.06 mg / ml while vitamin C antioxidant activity is 3.63 mg / ml, it means to inhibit 50% of radical compounds required amount of vitamin C lower than tomato extract. Further supported by Blouis (1958) statement, tomato extracts and this vitamin C has strong activity of vitamin C because it has IC 50 of less than 200 mg / ml.

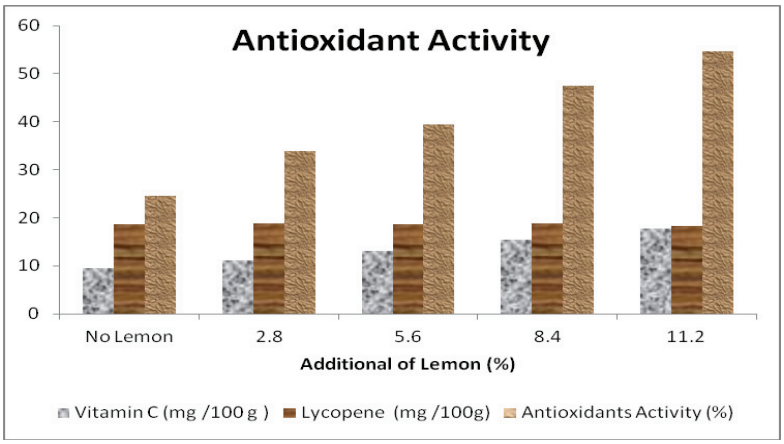

Fig. 1. Antioxidant activity of tomatoes jelly drink

3.4. Organoleptic Assessment

Organoleptic assessment is one important factor to determine degree of preference for a food product. A level assessment of products made using hedonic scale of 1 to 5, meaning that 1 = extremely dislike, 2 = dislike, 3 = somewhat like, 4 = likes, 5 = very like the next panelist assessment results are tabulated based distribution panel assessment are average selection of panelists on each parameter tested. Here are results of observations made in sensory analysis (Figure 2).

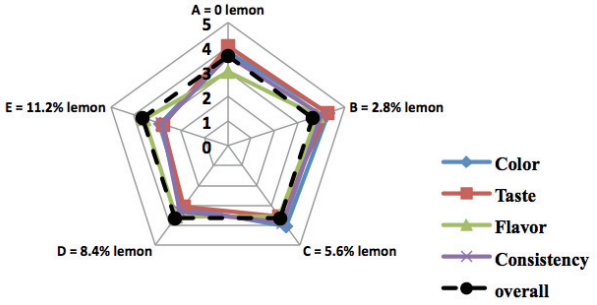

Fig 2. Result of sensory evaluation on tomatoes jelly drink

In general, the panelists liked almost all the tomato jelly drink product, except for treatments E, less preferred on the parameters of color and consistency. The higher the addition of lemon juice typical red color of tomatoes decreased, where as the lower the beverage consistency). Assessment taste and flavor to all the addition of lemon juice treatment preferred by the panelists, it can be concluded the addition of lemon can improve the taste of tomato jelly drinks.

Taste is a very important factor in determining the acceptance or rejection of foodstuffs by the panelists. The taste is closely connected with the aroma, both of which are components of flavor (taste). Owned sour taste lemon juice derived from organic acids, such as citric acid and malic acid (Snyder, 2009).

4. Conclusion

Based on the research results can be concluded that:

1. Processing tomatoes into a jelly drink can increase lycopene content in the product
2. The addition of lemon juice can increase the amount of vitamin C and the antioxidant activity of tomato jelly beverage products

3. Level of concentration addition of lemon juice gives significant effect on the value of pH, total acid, vitamin C, total dissolved solids and viscosity, but gives no real effect on levels
4. Treatment addition of lemon juice up to 8.4% against tomato jelly beverage products still to do. Acceptance panellist at the level regular up like, with characteristics include viscosity, 3.46 dps, pH, 3.6, Total acid, 0.60%, Vitamin C, 15.51 (mg / 100 g material), total solids 1 5.46 $^{(0}$ Brix), lycopene 18.76 (mg / 100g), and the antioxidant activity of 47.54%.

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