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DRAGON FRUIT JUICE ADDITION IN PALM OIL-PUMPKIN EMULSION: PANELIST ACCEPTANCE AND ANTIOXIDANT CAPACITY

[Penambahan Jus Buah Naga dalam Emulsi Minyak Kelapa Sawit-Labu Kuning: Penerimaan Panelis dan Kapasitas Antioksidan]

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ABSTRACT

Addition of dragon juice to emulsion products formulated from olein fraction of red palm oil and pumpkin juice was conducted as an effort to improve the taste thus it can be accepted by consumers. This study aims to (1) observe the acceptance of 60 panelists aged 17-21 years on the parameters of taste, aroma, mouthfeel, color, flavor and aroma of each contributing components of dragon fruit, palm oil, and raspberry flavor with the addition of dragon fruit juice at level 0 (control), 25, 50, and 75% (v/v), and (2) observe the changes in chemical components *i.e.* vitamin C and total titrable acids, total carotenoid by spectrophotometry, and antioxidant activity by 2,2-diphenyl-1-picrylhdrazyl (DPPH) reduction method. The best formula was the one containing 75% (v/v) of red dragon juice in fresh condition with vitamin C content of 19.32±0.62 mg/100 mL, antioxidant activity of 354.25±0.77 ppm, hedonic color, taste, and viscosity between favorable and very favorable. After 2 weeks of storage at room temperature (28±2ºC), the vitamin C, total carotene, and antioxidant activity of the mixture decreased by 29.72, 15.44, and 46.59%, respectively.

Keywords: dragon fruit, emulsion, pumpkin, palm oil oleic fraction

ABSTRAK

Penambahan sari buah naga pada minuman produk emulsi hasil formulasi fraksi olein minyak sawit merah dan sari labu kuning dilakukan sebagai upaya meningkatkan kualitas rasa sehingga dapat diterima konsumen. Penelitian ini bertujuan untuk (1) mengamati penerimaan panelis yang dilakukan terhadap 60 panelis berusia 17-21 tahun terhadap parameter penerimaan rasa, aroma, mouth feel*, warna, kekuatan rasa dan aroma dari masing-masing komponen pembentuk rasa yaitu buah naga, minyak sawit, dan perasa raspberry dengan penambahan sari buah naga pada taraf 0 (kontrol), 25, 50, dan 75% (v/v), dan (2) mengamati perubahan komponen kimia yaitu vitamin C dan total asam tertitrasi dengan menggunakan metode titrasi, total karotenoid menggunakan spektrofotometri, dan aktivitas antioksidan menggunakan metode reduksi 2.2-diphenyl-1-picrylhdrazyl (DPPH). Perlakuan terbaik didapatkan pada formulasi dengan 75% (v/v) sari buah naga merah dalam keadaan segar dengan nilai vitamin C 19,32±0,62 mg/100 mL, aktivitas antioksidan 354,25±0,77 ppm, hedonik warna, rasa, dan kekentalan antara disukai dan sangat disukai. Setelah disimpan selama 2 minggu pada suhu (28±2ºC), produk mengalami penurunan kadar vitamin C, total karoten, danaktivitasantioksidan masing-masing sebesar 29,72; 15,44; dan 46,59%.*

Kata kunci: *buah naga, labu kuning, emulsi, fraksi olein minyak sawit merah*

INTRODUCTION

Indonesia is a country that has indication of vitamin A deficiency. Since 1970 until today, public health facility gives vitamin A supplementation to under five-year-old children, scheduled in February and August. Despite the effort, Nadya (2010) stated that blindness occurred at a rate of one person per minute due to vitamin A deficiency. In a bigger picture, according to WHO (2009), there were estimated 250 million pre-school children across the world were experiencing a shortage of vitamin A. Every year, there are about 250-500 thousand children suffered to blindness. Half of this population perish in a period of 12 months due to lack of vitamin A. It is a fact that vitamin A supplementation is not aimed for children who are aged over 60 months and for pregnant and lactating women. The supplementation of pro-vitamin A is also important

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for people who have imbalanced diet and in post surgery recovery stage.

Alternatively, dietary vitamin A may be obtained through other modes of supplementation and fortify-cation of pro-vitamin A. Preparation of pro-vitamin A supplementation is based on local resources emerges as an important alternative. This research attempts to produce formula of pro-vitamin A supplement from local ingredients of red palm oil (MSM) and pumpkin with addition of dragon fruit (*Hylocereuspolyrhizus*) for masking the undesirable flavor. Further, local small food industry may produce the emulsion without high investment.

In this direction, a prototype was firstly developed from emulsion of deodorized oleic fraction of MSM (FO-MSM) and pumpkin juice with cinnamon powder as additive. This first prototype contains 141.65±0.47 ppm of trans β-carotene or equal to 237 UI/mL vitamin A activity (Rahmadi *et al.,* 2015). As one of the main raw materials, FO-MSM is recognized to have macro and micronutrients that are beneficial to human health during growth period and to reduce the risk of several diseases. The functional compounds in FO-MSM are α, β, and γ-carotene, α-tocopherol, and tocotrienols (Mba *et al.,* 2015). From HPLC profile of the previous prototype, pumpkin shares a good source of other pro-vitamins A compounds, characterized as xanthin and lutein (Rahmadi *et al.,* 2015). The first prototype had several weaknesses in quality. The first weakness was after taste of FO-MSM that was pronouncedly traceable (Rahmadi *et al.,* 2015). Factor affecting the after taste may fall to less effective deodorization process during the preparation of FO-MSM and the use of orange flavor that could not cover the off taste of the emulsion product. In addition, no previous observation was conducted for the stability of the active ingredients of the first prototype after being stored in a certain storage period. It is concerned that the antioxidant activity of the emulsion products decreased after a period of storage for two weeks at room temperature (28±2ºC).

It is technically difficult for small industry to eliminate FO-MSM distinct taste and odor without further destroying the trans β-carotene α-tocopherol, and tocotrienol contents. Hence, to solve the first problem, one possible effort is to cover the undesirable odor with masking technique by addition of other materials (Martinez *et al.,* 2016). Dragon fruit, which is abundant in this region, emerges as a candidate to mask the off taste and odor. Pectin of dragon fruit may function as matrices that traps the undesirable flavor compounds of the emulsion prototype (Cervantes-Paz *et al.,* 2016). In addition, dragon fruit has bioactive substances including antioxidants in the form of ascorbic acid and betalain (Thirugnanasambandham and Sivakumar, 2017).

This study was conducted to: (1) reformulate the prototype with the addition of dragon fruit juice at level 0 (control), 25, 50, and 75% (v/v); (2) observe the panelists acceptance to general flavor, aroma, mouth feel, and color, and off flavor masking capability of dragon fruit juice and raspberry flavor additive; (3) observe changes of antioxidant components namely vitamin C, total carotenoids and antioxidant activity by the method of reduction of 1.1-diphenyl-2-picrylhdrazyl (DPPH) before and after storage for two weeks at room temperature (28±2ºC).

MATERIALS AND METHODS

Materials

This research was conducted in a five-stage process, namely the production of FO-MSM from CPO, pumpkin and dragon fruit juice, emulsion products of red dragon fruit, pumpkin and FO-MSM (Rahmadi *et al.,* 2015) with procedures and treatments that have been determined as well as the test phase of the emulsion produced.

FO-MSM production

About 300 mL of CPO (PT. Waru Kaltim Plantation, Penajam Paser Utara, Indonesia), with criteria of less than 3% of Free Fatty Acid (FFA), was subjected to FFA neutralization and gum removal process by addition of 400 μL of 10% NaOH (Sigma-Aldrich, USA) in 100 mL of warm water (80-90°C) following thorough mixing for 1 minute in a separating funnel, then disposal of residual water. Flushing was performed with warm water (70-80ºC) as much as 50 mL in repeated fashion. Litmus paper was used to qualitatively detect traces of NaOH. In MSM, FFA levels were checked to be under 1%. Oleic fraction was separated after MSM being kept overnight in room temperature. FO-MSM was deodorized in rotary vacuum evaporator (Buchi, Italia) for 5 hours at the condition of 60 rotations per minute (RPM), 100ºC, and 85±5 mmHg (Rahmadi *et al.,* 2015). FO-MSM that has been obtained was then stored in a dark sealed container at 8±2ºC.

Pumpkin and dragon fruit juice preparation

About 1 kg of pumpkin and dragon fruit was peeled and cut to the size of 3-5 cm on its longest side and then washed with tap water. Furthermore, each fruit was crushed into juice and filtered to remove the pulp. Each juice was pasteurized at 80ºC for 10 minutes and stored at 8±2ºC.

Production of the emulsion

About 5 mL of FO-MSM was mixed with 95 mL of pumpkin juice. CMC 2% (w/v), xanthan gum 2% (w/v), ground cinnamon 0.5% (w/v) were homogenized. Dragon fruit juice and warm water (80-90°C) were added in accordance to the formulation (v/v) to produce 400 mL of emulsion volume. About 10% of fructose syrup (v/v), 0.25% of citric acid (w/v), and 0.1% (v/v) of raspberry flavor additive were mixed into the emulsion. Samples were filtered and placed in dark glass bottles, each containing 100 mL of emulsion. Emulsion then was sterilized at 121ºC for 15 minutes. Some samples were directly analyzed and the rests were stored for two weeks at room temperature (28±2ºC).

Panelists acceptance and taste traceability

Hedonic test was used to measure the acceptance and taste traceability of all four formulations according to Montenegro *et al.* (2015). In the acceptance test, as many as 60 panelists aged of 17-21 years male-female balanced were prompted to assess reception parameters of taste, aroma, mouth feel, and color. Figures obtained were in scale of: one (1) for very unfavorable, two (2) for unfavorable, three (3) for neutral, four (4) for favorable, and five (5) for very favorable. Traceability test performed by 60 panelists on the strength of flavor and aroma of each constituent in the emulsion namely dragon fruit, palm oil, and raspberry. Figures obtained were in scale of: one (1) for very untraceable, two (2) for untraceable, three (3) for slightly traceable, four (4) for traceable, and five (5) for very traceable (Soekarto. 1985). Data were analyzed with nonparametric ANOVA using Graph Pad Prism 6. If there is significantly difference at the level of α 5% of variance, then data were tested further by Dunnet multiple comparisons test.

Vitamin C and titrable total acidic content

Vitamin C and titrable total acidic content were measured according to Sudarmadji *et al.* (2007). Standard and chemicals were purchased from Sigma-Aldrich (USA).

Total carotene

Total carotene was measured with PORIM (1995). Each emulsion product was weighed at 0.1 g and put into a 25 mL flask. The sample was dissolved in n-hexane (Merck-Millipore, USA) and mixed until completely homogeneous. The absorbance of the filtrate was measured at 446 nm (Genesys 20, Thermo Fischer). Total carotene was calculated with equation (1):

$$T = (25 \times (a-b) \times 383)/(100 \times W) \quad \text{.........................} 1$$

where, T = Total carotene (ppm), a = sample absorbance, b = blank absorbance, W = sample weight (g).

Antioxidant activity by DPPH reduction

Test of antioxidant activity was measured as the inhibition of the reduction of DPPH (Sigma Aldrich, USA). A total of 1 mL of different concentrations of the extract was added to 1 mL of DPPH (0.15 mM in ethanol) and at the same time, control consists of DPPH 1 mL with 1 mL of ethanol (Kimia Farma, Indonesia) was prepared. The solution was mixed and incubated in a dark room (28±2ºC) for 30 minutes. The absorbance was measured at 517 nm, where ethanol was used as a blank. For antioxidant activity, IC_{50} value was determined using linear regression at concentrations of 31.25, 62.5, 125, 250, and 500 ppm. Observations were carried out in three replicates.

RESULTS AND DISCUSSION

Panelist acceptance

Acceptance of panelists was recorded to the parameters of color, flavor, aroma, and mouthfeel (Table 1).

Table 1. Panelist acceptance on addition of dragon fruit juice in the emulsion prototype

Parameter	Addition of Dragon Fruit Juice (V/V)			
	0%	25%	50%	75%
Likeness				
Color	3.4±0.7^{a}	3.9±0.9^{bc}	3.8±0.6^{ab}	4.1±0.9^{c}
Taste	2.8±0.7^{a}	3.3±0.8^{b}	3.8±0.6^{c}	4.3±1.0^{d}
Aroma/flavor	3.2±0.8^{a}	3.2±0.8^{a}	3.8±0.5^{b}	4.0±0.8^{b}
Mouthfeel	3.0±0.7^{a}	3.4±0.7^{a}	3.8±0.6^{b}	3.8±0.9^{b}
Traceability of taste				
Dragon fruit	1.5±0.6^{a}	2.9±0.6^{b}	3.8±0.5^{c}	4.5±0.8^{d}
Raspberry	3.6±0.6^{a}	3.4±0.7^{a}	3.3±0.5^{a}	3.1±0.9^{a}
Palm oil	3.0±0.9^{a}	2.7±0.8^{ab}	2.5±0.8^{bc}	2.0±1.2^{c}
Traceability of aroma				
Dragon fruit	1.4±0.5^{a}	2.7±0.5^{b}	3.8±0.6^{c}	4.4±0.8^{c}
Raspberry	3.3±0.7^{a}	3.3±0.7^{a}	3.3±0.7^{a}	3.2±1.0^{a}
Palm oil	2.8±1.0^{a}	2.5±0.7^{ab}	2.3±0.7^{bc}	2.1±0.9^{c}

Notes: Acceptance scale: 1 = very unfavorable, 2 = unfavorable, 3 = neutral, 4 = favorable, 5 = very favorable; Traceability of taste and aroma scale: 1 = very untraceable, 2 = untraceable, 3 = slightly traceable, 4 = traceable, 5 = very traceable; n = 60; letters after the numbers indicating the least significant difference at α=5%

The panelists generally preferred the addition of dragon fruit juice into emulsion formulation. It was evident that the increasing acceptance of the color and the taste was directly proportional to the concentration of dragon fruit juice that were added. To parameters of aroma and mouth feel, increased acceptance of panelists was observed in additions of dragon fruit juice by 50% (v/v).

Flavor masking principle works as to increase taste and aroma of other substance to reduce or mute specific off odor and taste in a formulation. Target of flavor masking is normally bitter, rancid, and strong organic acids and volatiles (Granato *et al.*, 2010). Common substances added to mask unwanted flavor are sweet, spices and fruits (Martinez *et al.,* 2016). Flavor masking applied for palm oil is deliverable through encapsulation (Rutz *et al.,* 2017), compound binding, addition of stronger and muting flavor substance (Damodaran and Arora, 2013). Acceptance panelist on parameters of dragon fruit flavors and aromas are consistently improve with increased concentration of dragon fruit juice. This has an impact on the decrease in the off taste and odor of the FO-MSM. This signifies that the dragon fruit was suitable to mask taste for FO-MSM in the emulsion.

Vitamin C and total acid content

Dragon fruit contains vitamins and minerals, including vitamin C at 33–55 µg/g of fresh fruit (Isabelle *et al.,* 2010). The addition of dragon fruit juice significantly improves vitamin C content of the emulsion (Figure 1A). This result is in line with the increase of titrable acid content, which in this prototype is produced from vitamin C content of the fruit juice and citric acid added as preservative (Figure 1B). After two-week storage period, significant decrease of vitamin C content was observed in all formula.

Storage plays an important role on the quality of products, including vitamin C. Vitamin C is a vitamin that is easily oxidized by light, treatment with heat, and free radicals (Sahidi and Zhong, 2010). It is deduced that reduction in the concentration of vitamin C in the formulation of the added dragon fruit juice in the prototype is due to its role of protecting the emulsion from the formation of FFA and other radical components during storage of products (Sancho *et al.,* 2011).

Total carotene

The addition of dragon fruit juice caused decline in the total content of carotenoids from the emulsion. At first, the content of total carotenoids was 133.4±2.9 ppm in the control formula, and linearly down to 33.5±10.5 ppm on the addition of dragon fruit juice as much as 75% (v/v) (Figure 2). Linear equations formed from a decrease in total carotene formulations due to the addition of fresh dragon fruit was: total carotene (ppm) = (-1.25±0.10) [dragon fruit juice] + (128.9±4.52) at correlation (r) of 0.943. On the decline of total carotene in the formula that had been stored for two weeks, the linear equation was: total carotene (ppm) = (-1.31±0:09) [dragon fruit juice] + (118.6±4.15) at a correlation (r) of 0.956.

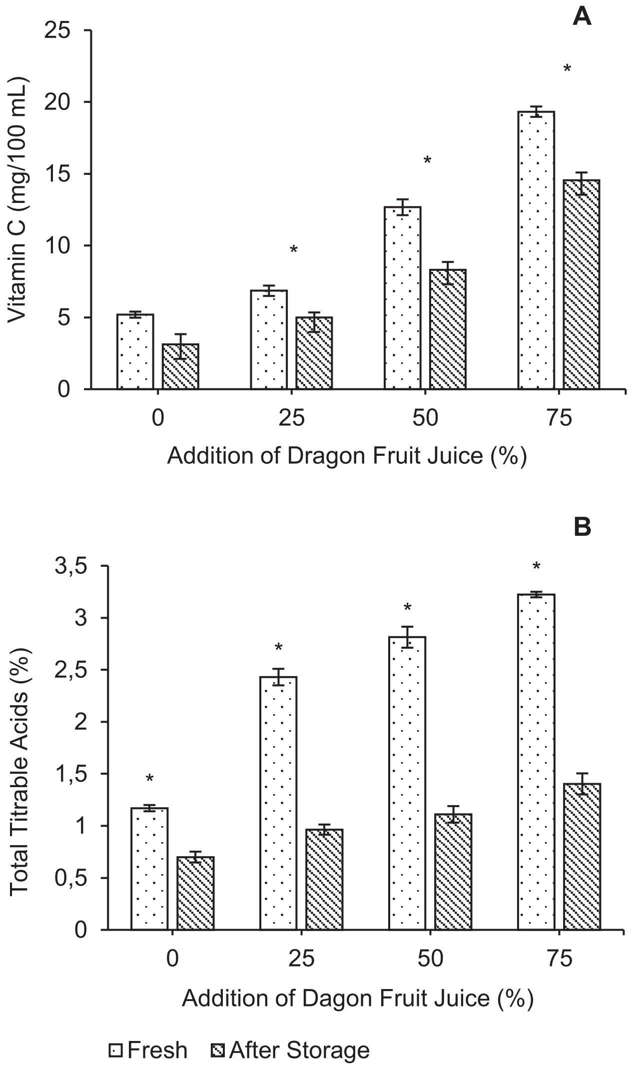

Figure 1. Vitamin C (A) and total titrable acid (B) contents on addition of dragon fruit juice in emulsion prototype before and after storage. ┬ indicates Standard Error of Mean (SEM); *Indicates significant different based on Multiple T-test. Storage duration was two weeks at 28±2ºC

Pectin is a component of dragon fruit that is recognized to bind carotene and other bioactive substances, hence the bioavailability of carotene becomes low (Soukoulis *et al.,* 2016). Moreover, Cervantes-Paz *et al.* (2016) stated that to increase bioavailability of carotene in an emulsion product, keeping stability of oil micelles is important to prevent carotene binding to pectin matrices. Other effort to increase bioavailability of β-carotene in any emulsion product is to esterified methyl group of pectin (Verrijssen *et al.,* 2016).

After being stored for two weeks at room temperature (28±2°C), total carotenoids than the control formula down from 133.4±2.9 to 119.7±9.4 ppm, although not statistically significant. The significant decline in total carotene in the products after stored for two weeks occurred for formula with 25 and 50% (v/v) addition of dragon fruit juice in the emulsion prototype.

Nhung *et al.* (2010) stated that β-carotene tends to in stable condition during one week storage, but reduces rapidly after two-week storage. Degradation of β-carotene occurs because of heat and light exposure, exceedingly low water activity, and prolonged storage. Beta-carotene declines as a result of water activity follows pseudo-first order reaction (Lavelli *et al.,* 2007). The decrease of β-carotene in carrot product due to heat exposure categorized in first order reaction (Koca *et al.,* 2007). Oxidation is the main cause of the decline carotene content in the product, which is a free radical downstream reaction caused by the presence of oxygen, enzymes, light, and metal and peroxide substances (Sánchez-Moreno *et al.,* 2003). It is deduced that oxygen present in the head-space of the bottle affected the decrease in the degradation of components in the emulsion prototype, resulting in decreased product overall quality.

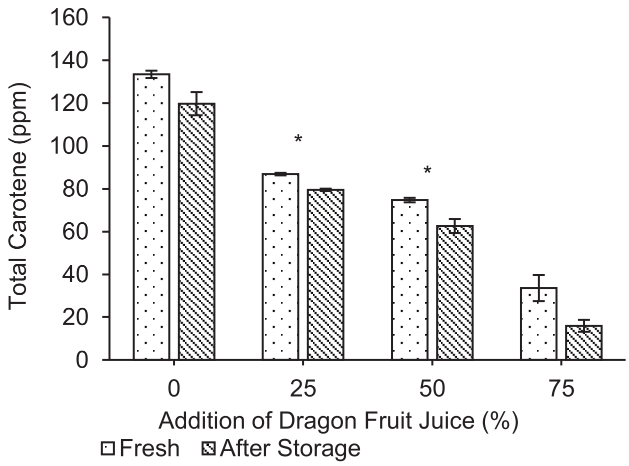

Figure 2. Total carotene on addition of dragon fruit juice in emulsion before and after storage. ┬ indicates Standard Error of Mean (SEM); *Indicates significant different based on Multiple T-test. Storage duration was two weeks at 28±2ºC

Antioxidant capacity

Antioxidant capacity changes because of the addition of dragon fruit juice into the emulsion prototype measured by the ability to inhibit the reduction of DPPH compound. The smaller the value of 50% inhibitory concentration (IC_{50}) was, the stronger the antioxidant content of the resulting formula. In this case, the product with the addition of dragon fruit juice as much as 75% (v/v) has the best ability to inhibit DPPH reduction with the IC_{50} value of 354.3±1.4 ppm. Vitamin C presence from the added dragon fruit juice contributed to the increase of antioxidant capacity. From Figure 3, the increased antioxidant activity was in line with the increasing addition of dragon fruit juice.

After being stored for two weeks at room temperature (28±2ºC), antioxidant capacity of all formula decreased, indicated by the increase of IC_{50}values of inhibition of DPPH reduction. This indicates degradation of the antioxidant component in all formula. Formula that contained 50% (v/v) of dragon fruit had the highest increase of IC_{50} value that was from 497.2±2.5 to 663.3±1.8 ppm (Figure 3). After storage for two weeks, the increase in value of IC_{50} of inhibition of DPPH reduction linked to decreased levels of vitamin C (Figure 1A). A de-crease in antioxidant capacity because of the deposit also occurs in the fruit juice based product (Castro-López *et al.,* 2016). One of the efforts to prevent a decrease in antioxidant capacity is to store in cold temperatures, so that the oxidation reaction can be decelerated (Plaza *et al.,* 2011).

Figure 3. IC_{50} of inhibition of DPPH reduction on addition of dragon fruit juice in emulsion prototype before and after storage. ┬ indicates Standard Error of Mean (SEM); *Indicates significant different based on Multiple T-test. Storage duration was two weeks at 28±2ºC

A decrease in antioxidant capacity may also occur due to decreased levels of carotene in the product. Carotene is one of the antioxidant compound that can block the process of oxidation caused by light (photo-oxidation), due to quenching ability (Qian *et al.,* 2012). A decrease in antioxidant activity is due to the degradation of other carotenoid compounds in emulsion product.

CONCLUSION

Dragon fruit juice was suitable as flavor mask for FO-MSM off taste and odor in the emulsion prototype. The best prototype formulation was with addition of 75% (v/v) of dragon fruit addition in fresh condition with 19.32±0.6 mg/100 mL of vitamin C, value of, 33.5±10.5 ppm of total carotene, 354.3±1.4 ppm of IC_{50} of inhibition of DPPH. The formula had the highest acceptance of color, aroma, taste, and mouth feel between favorable (score 4) and highly favorable (score 5). The ability to inhibit reduction of DPPH increases with the addition of dragon fruit into the prototype. Once stored for two weeks at 28±2ºC, the contents of vitamin C andtotal carotene as well as antioxidant activity were degraded. The addition of dragon fruit juice resulted in a decrease in total carotene approximated by a linear equation. Carotene binding by pectin matrix phenomenon had occurred in the prototype; therefore, further reformlation is in need.

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