Total β-carotene of β-carotene carrot powder (*Daucus Carota* L.) encapsulation result

M Rifqi¹, I S Setiasih² and Y Cahayana²

¹ Magister Technology Agroindustri, Faculty of Agro-Industrial Technology, Padjadjaran University, Jatinangor, 45363, Indonesia
² Faculty of Agro-Industrial Technology, Padjadjaran University, Jatinangor, 45363, Indonesia

Email: rifqimuhammadsuryana@gmail.com

**Abstract.** β-carotene is a compound that forms red, orange and yellow pigments in carrots. β-carotene compounds in the form of liquid extract have weaknesses that are unstable, impractical in terms of storage, and have a short shelf life so that further treatment is needed to produce β-carotene with better characteristics, one of method is encapsulation using maltodextrin. This study aims to determine the best concentration of maltodextrin β-carotene. The research method used was an experimental method with one-way analysis of variance (ANOVA) with a confidence level of 95% consisting of 3 treatments with 3 replications, namely the addition of 10%, 20%, and 30% (b/v). The results showed that β-carotene carrot powder with the addition of 20% maltodextrin produced the highest total β-carotene which was 29.160 ppm.

**Keywords:** β-carotene carrots, Encapsulation, Maltodextrin, β-carotene carrots powder, and Total β-carotene

1. Introduction

Carrots (*Daucus carota* L.) are horticultural commodities that have been widely developed in Indonesia [1]. West Java is the second largest carrot producing region after Central Java where this region is able to produce carrots as much as 139,905 tons part year [2]. Carrots have quite interesting colors. The color pigments contained in carrots are β-carotene which is a subclass of carotenoids [3]. The presence of β-carotene found in carrots is shown in red, orange, and yellow [4].

Quite a lot of researchers are interested in researching carrots because carrots contains natural compounds, namely β-carotene which is antioxidant and can counteract free radicals [5]. The content of β-carotene in carrots ranges from 65–83 ppm [6]. The antioxidant content found in carrots can reduce the risk of degenerative diseases, such as cancer, heart disease, and eye cataracts [7]. B-carotene is a non-polar compound so that to produce preparations of β-carotene compounds from carrots can be extracted using n-hexane, acetone, and mixtures of these two solvents [8]. Non-polar compounds will dissolve in non-polar solvents, while polar compounds will dissolve in polar solvents [9].

The use of n-hexane solvent on β-carotene extraction from carrots can produce more extracts compared with β-carotene extract extracted using acetone [8]. The mixture between n-hexane and acetone on extraction of β-carotene from carrots produced more extracts compared with extracted β-
carotene extracted using only n-hexane [9]. The use of suitable solvents is a determining factor for the amount of β-carotene extract produced [10].

β-carotene compounds in the form of liquid extract have weaknesses that are unstable, impractical in terms of storage, and have a short shelf life [11]. Natural compounds such as β-carotene can be damaged if stored too long. Based on this, action needs to be taken regarding the manufacture of powder preparations from extracts of carrots β-carotene. The process of making β-carotene carrot powder can be done by the encapsulation method, namely, the method used to convert the material from liquid form to powder form by combining coating materials and desiccant machines, one of which is a vacuum oven [12].

One of the coating materials used to overlay the material in the encapsulation method is maltodextrin [13]. Maltodextrin is effectively used as a β-carotene pigment coating material because it has a higher solubility, low hygroscopic, strong binding capacity, is capable of forming films, helps the dispersion process, and inhibits crystallization [14].

The use of maltodextrin can protect the content of β-carotene which has β-carotene powder extended from carrots [8]. The use of maltodextrin with the addition of the right concentration will produce gac fruit aril powder with the highest total β-carotene [11]. Based on the background above it can be concluded that the use of maltodextrin is effective in protecting food containing β-carotene. The purpose of this study was to determine the best maltodextrin concentration to maintain total β-carotene from β-carotene carrot powder.

2. Material and method

2.1. Material

Chante nay carrots with a size of 15–18 cm and age 3 months from the spread of seeds weighing around 200- 600 grams were obtained from the Main Market Caringin (Bandung, Indonesia). Reagents used in this study such as n-hexane, acetone, aquedest and DPPH.

2.2. Extraction of β-carotene from carrots

Carrots are cut into small pieces and then mashed using a blender. After smooth, then weighed as much as 100 grams. A total of 100 grams of refined carrots are then macerated using a magnetic stirrer which is extracted using a solvent, which is a mixture of n-hexane and assets extracted using solvents which is a mixture of n-hexane and acetone with platform with comparison (1: 1). The results of the extracts were concentrated using a rotary evaporator so that thick or thick β-carotene extracts of carrots were obtained.

2.3. Making carrotene β-carotene powder with microencapsulation method

Carrotene β-carotene extract added maltodextrin as much as 10% (w/v), 20% (w/v), and 30% (w/v) from concentrated extracts. Then extracts and added maltodextrins were stirred until all of them were mixed using magnetic strearer. The purpose of adding maltodextrin is as a coating that serves to protect β-carotene in the extract so that it can be maintained during the drying process into powder. The extract mixed with maltodextrin was then dried using a vacuum oven at 50°C for approximately 120 minutes. The purpose of drying is to change the form of extract into powder.

2.4. Identification of total β-carotene

Weigh the sample as much as 10 grams, add 8 ml aquedes, homogenize it by shaking it with vortex, then take 2 ml into the test tube, add 2 ml of 96% alcohol and 10 ml diethyl ether (DE). After that, shake for 2 minutes using vortex and centrifuges for 3–5 minutes. The DE layer is formed and marked as layer I, the rest (after taking DE (layer I)) is added again with 10 ml PE. The mixture is shaken again for 2 minutes (homogenize with vortex) then centrifuged for 3–5 minutes. The DE layer is formed and marked as layer II which is united with layer I. Taken 2 ml (from mixture I + II) then read immediately at a wavelength of 450 nm.
2.5. Statistical analysis
The research method used was an experimental method using a randomized block design (RBD) with 3 treatments and 3 repetitions. The treatment taken is the manufacture of carrot β-carotene powder using various concentrations of maltodextrin.

3. Results and discussions

3.1. Total β-carotene carrots extracted using N-hexane and acetone

| Treatment                  | Average Total β-Carotene (ppm) |
|----------------------------|---------------------------------|
| N-Hexan: Aceton (1:1)      | 33.67 ± 1.02                    |

The final yield of β-carotene extract from carrots is influenced by the number of components extracted during the extraction process. Where the success of the extraction process is largely determined by the use of solvents. Suitability of the solvent with the components to be extracted will produce a high yield. Polar components will dissolve in polar solvents, as well as nonpolar components which will dissolve in nonpolar solvents [15]. N-hexane is a non-polar solvent that can dissolve nonpolar materials as well. Non-polar compounds such as β-carotene are easier to elute with non-polar solvents such as N-hexane [16].

The addition of acetone aims to increase extraction where the components of β-carotene dissolve well in organic solvents such as carbon disulfide, benzene, chloroform, acetone, ether and petroleum ether [17]. The mixture of non-polar n-hexane and polar acetone helps extract the highest amount of β-carotene. β-carotene which occurs naturally is found in cells and surrounded by aqueous protoplasmic media, so that acetone can bind water and force β-carotene to come out of solution [13]. The extraction results using a mixture of n-hexane and acetone produced an average total β-carotene of 33.67 ppm. This value is in line with the research [18], using n-hexane, acetone, and ethanol solvents on β-carotene extraction in carrots with a total of β-carotene of 34.94 ppm. Total β-carotene is influenced by the heating process wherein this research is carried out evaporation using a rotary evaporator at a temperature of 40 oC. The heating process in β-carotene decreases the content of β-carotene because β-carotene is isomerized from the Trans form to the cis form [19]. In this study, the heating temperature limit was not clearly measured so that it could not determine the temperature of β-carotene damage during the extraction process.

3.2. Effect of addition of maltodextrin concentration on total β-carotene in carrotene β-carotene powder

The treatment of the addition of maltodextrin concentration had a significantly different effect on the total β-carotene in the β-carotene carrot powder produced. The results of calculating the total statistics of β-carotene in β-carotene carrot powder can be seen in table 2.

| Treatment                  | β-Carotene (ppm) |
|----------------------------|-------------------|
| A: Maltodextrin 10% (w/v)  | 15.258 ± 0.748a   |
| B: Maltodextrin 20% (w/v)  | 29.160 ± 0.433c   |
| C: Maltodextrin 30% (w/v)  | 21.025± 0.659b    |

Remarks: The average treatment marked with the same letter is no different real according to Duncan’s Test at the level of 5%

The results of statistical testing with the Duncan test at the level of 5% showed that the β-carotene carrot powder with various treatments adding the concentration of maltodextrin had a significant effect on total
β-carotene on β-carotene carrot powder. The total β-carotene of β-carotene carrot powder in table 2 shows that treatment A had a significantly different effect on treatment B and C, treatment B had a significantly different effect on treatments A and C, and treatment C also had a significantly different effect. Towards treatment A and B. This shows that each treatment had a significantly different effect on total β-carotene on carbohydrate β-carotene powders.

The average results showed that the treatment of the addition of maltodextrin concentrations of 10% to 30% resulted in a significant difference to the total β-carotene in carrots β-carotene powder. B-carotene carrot powder with the addition of 20% maltodextrin has the highest total β-carotene compared to β-carotene carrot powder given the addition of maltodextrin 10% and 30%. The results of total β-carotene analysis on β-carotene carrot powder based on table 8, it can be seen that the total β-carotene in the highest carbohydrate β-carotene powder in the treatment of addition of 20% maltodextrin is 29.160 ppm and the lowest is the addition of 10% maltodextrin which is 15.258 ppm.

Addition of maltodextrin to total β-carotene in carrots β-carotene powder is not in accordance with [2] where the addition of maltodextrin was followed by a decrease in the total amount of β-carotene. Total β-carotene in the addition of 10% maltodextrin concentration in tempurung fruit powder produced a total of β-carotene of 790 ppm whereas in the addition of 20% and 30% maltodextrin concentration, the total β-carotene in the gac fruit aril powder decreased to 470 ppm and 300 ppm.

In this study the total β-carotene at 20% maltodextrin concentration increased compared to 10% maltodextrin concentration, but again decreased at a concentration of 30%. The addition of 20% maltodextrin is the right concentration to produce the highest carbohydrate β-carotene powder with the highest total β-carotene. Maltodextrin in a small amount of 10% is not too maximal in coating or protecting β-carotene components found in β-carotene carrot powder while the addition of maltodextrin in large amounts is 30%, because maltodextrin is white while the complex color of β-carotene compounds is shown in red, so that when measured on a spectrophotometer the intensity of the red color decreases which results in a decrease in total β-carotene [14].

3.3. Visual Appearance Carrot β-carotene Powder
Visual appearance is the most important thing that is considered in choosing something or a product. The following is a visual appearance of the β-carotene carrot powder presented in table 3.
Table 3. Visual appearance of carrots β-carotene powder.

| Treatment          | Picture          | Color        |
|--------------------|------------------|--------------|
| Maltodextrin 10%   | ![Image](image1) | Reddish White ++ |
| Maltodextrin 20%   | ![Image](image2) | Reddish White + |
| Maltodextrin 30%   | ![Image](image3) | Reddish White |

Description: +++: very thick; ++: concentrated; +: rather thick

Based on table 3 the color of β-carotene carrot powder against various concentrations of maltodextrin, there are differences in color levels. The higher the concentration of maltodextrin in carrots β-carotene powder, the reddish white decreases. It can be interpreted that the increase in the concentration of maltodextrin causes the color of the β-carotene carrot powder to be brighter.

4. Conclusion

β-carotene carrot powder with various treatments, the addition of maltodextrin concentration has a significant effect on total β-carotene on β-carotene carrot powder. The treatment of adding maltodextrin concentrations of 10%, 20%, and 30% resulted in a total of β-carotene of 15.28 ppm, 29.160 ppm, and 21.025 ppm. β-carotene carrot powder with the treatment of 20% maltodextrin concentration was the best concentration which produced the highest total β-carotene in carrots β-carotene powder. The results of the study on β-carotene parameters indicate that β-carotene carrot powder with the treatment of the addition of the concentration of maltodextrin has the potential to maintain the chemical components contained in food in the form of powder.

References

[1] Ferdian H, Suryanto A and Wirdiyanto E 2017 Effect of Time of Giving Mulch on Carrots Production (*Daucus carota* L.) *Journal of Crop Production*

[2] Ministry of Agriculture 2018 Horticultural Production Statistics in 2016
[3] Putri G S V, Setiani B E and Hintono A 2017 Characteristics of Carrot Jam (Daucus carota L.) with Addition of Pectin. Food Technology Study Program. Faculty of Animal Husbandry and Agriculture. Diponogoro University. Semarang

[4] de Souza L P , Faroni L R A, Heleno F F, Cecon P R et al 2017 LWT - Food Sci. Technol. 90 53–60

[5] Radomska L B, Harasym J 2017 β-caroten-Properties and Production Methods Food Qual. Safety 2(2) 69–74

[6] Penecaud. C, Achir. N, Mayer. C. D, Donier. M, dan Bohoun. P 2011. Degradation Of β-caroten during Fruits and Vegetable Processing or Storage: Reaction Mechanisms and Kinetic Aspects: a review Fruits 66(6) 417–40

[7] Nururrrahmah, and Widiarnu. W. 2013. Analysis of Beta-Carotene Content of Fruit Skin Naga Using a UV-Vis Spectrophotometer. Chemistry Study Program. Faculty of Natural Sciences. Cokroaminoto Palopo University. South Sulawesi

[8] Sregelj V N, Cetkavic G S, Brunet M C, Saponjac V T T and Stajcic. J J V S 2017. Extraction and Encapsulation of Bioactive Compounds from Carrots Acta Perrodica Technol. 48 261–73

[9] Rebecca L J, Sharmila S, Das M P and Seshiah C 2014 Extraction and Purification of Carotenoids from Vegetables J. Chem. Pharm. Res. 6(4) 594

[10] Yulianti B 2014 Multi-level extraction of β-carotene from Carrots with Hexane and Petroleum Ether Solvents. Gorontalo University. Gorontalo

[11] Angkananonon. W., Anantawat. V 2015. Effects of spry drying condition characteristics, nutrional value and condition activity of gac fruits aril powder Rev. Integr. Bus.Econ. 4 1–11

[12] Bettega. R. Rosa. J. G., Correa. R. G., dan Freira. J. T 2014. Comparison of carrots (Daucus carota L) drying in microwave and in vakum microwave Brazilian J. Chem. Eng. 31(2) 403–12

[13] Morovat. M. H, dan Ghasemi. Y 2015. Spray Drying in Powdered Dunaliella Salina Biomass. Pharmaceutical Sciences Reseach Center. Department of Pharmaceutical Biotechnology School of Pharmacy Shiraz University of Medical Sciences

[14] Penecaud C, Achir N, Mayer C D, Donier M and Bohoun P 2011 Degradation Of β-Karoten during Fruits and Vegetable Processing or Storage: Reaction Mechanisms and Kinetic Aspects. 10.1051/fruits/2011058

[15] Yulianti B 2014 Multi-level extraction of β-carotene from Carrots with Hexane and Petroleum Ether Solvents (Gorontalo: Gorontalo University)

[16] Muslich, Prayoga S and Indri R H 2010 Adsorption of Isothermal β-Carotene Adsorption from Palm OleinRough Using Bentonite J. Tech. Ind. Pert. 19(2) 93–100

[17] Purnamasari N, Andriani M A M and Kawiji 2013 Effect of Solvent Types and Temperature Variations Spray Dryer Dryer or Carotenoid Levels of Red Oncom Molds (Neurospora sp.). Food Teknosains Journal 2(1) 107

[18] Agustina A, Hidayati N and Susanti P 2019 Determination of β-Carotene Levels in Raw Carrots (Daucus carota, L) and Boiled Carrots with Visible Spectrophotometry Muhammadiyah STIKES Klaten Central Java, Indonesia

[19] Updike A and Schwartz S 2003 Thermal Processing of Vegetables Increases cis Isomers of Lutein and Zeaxanthin J. Agric. Food Chem. 51(21) 84–90