The Effect of Temperature and Concentration of Foaming Agent to the β-Carotene Content in Product Derived from Carrots

Qonitah Fardiyah*, Barlah Rumhayati, Yuniesti Husnul Khotimah
Department of Chemistry, Faculty of Mathematics and Natural Sciences, Brawijaya University, Malang, Indonesia
Email: fardiyah@ub.ac.id

Abstract. Carrot (Daucus carota L) is vegetable that contain body essetial vitamins, especially β-carotene. In this research, the essense of fresh carrots are taken and processed to carrot powder using foam mat drying method. This research aims to study the effect of temperature and concentration of foaming agent to the β-carotene content in product derived from carrots. The temperature variation that used in this research are 40°C, 50°C, 60°C and 70°C, while he variation of foaming agent (tween 80) are 0,01% (v/v); 0,1%(v/v); 0,2%(v/v) and 0,3%(v/v). The results shows that the maximum drying temperature is 50°C with β-carotene content 10.55 mg/kg and the maximum concentration of foaming agent (tween 80) is 0.2%(v/v) with β-carotene content 10.36 mg/kg. Keywords: carrot, foam mat drying, tween 80, β-carotene.

1. Introduction
Carrots are one of the plated vegetables that are rich in alpha and beta carotene, Vitamin C, B, and minerals. The carotenes are essential for body as provitamin A. Besides, carrot also containing vitamin C, vitamin B and mineral especially calcium and phosphor [1].

The purpose of making carrot powder is to improve the quality of carrot products so that its utilization is more widespread and the storage time of carrot products becomes longer. In the process of making carrot powder requires special conditions for the content of carotene in carrots is not lost due to the nature of β-carotene sensitivity to oxygen and light. Therefore, in the process of making carrot powder required an effective and efficient drying method is the foam mat drying method. In this method, foaming agent is needed to accelerate the drying process, decreasing the water content and crumb powder. Foaming agent increasing the evaporation of water although the temperature is lower than water boiling point, dried product at 50 - 80°C contain 2-3% water [6].

Refer to Karim [7], foam-mat drying method have several advantages, such as easy to apply and cheaper than spray drying and freeze drying methods. According to Kudra and Ratti [8], foam-mat drying method have advantages, such as, faster drying, lower operation temperature, high quality product, good color and taste, and high solubility. Foam-mat drying method used to produce dry product from liquid that high sugar content.

Drying process in this method can be done by adding foaming agent. Foaming agent is a food additive that used to form and protect disperse homogenity of gas phase in solid or liquid food. Foaming agent that usually used are egg, tween 80, monostearicgliserol, xanthan gum,
microcrystalline cellulose, ethyl methyl cellulose. Foaming agent addition aims to increase the surface, decrease the surface tension, increasing pore, increasing water evaporation, and keeping material quality [9].

2. Experiment

2.1. Materials and Equipment
Material that used in this research are chentenay carrot, aquades, maltodextrin, citric acid p. a., tween 80 p. a., petroleum ether p.a., β-carotene powder p. a. (Merck Sigma).

2.2. Procedure
The absorbance of β-carotene was measured by Shimadzu spectrophotometer. The standard solution of β-carotene (1000 ppm) was prepared by dissolving 50 mg β-carotene p. a. in 50 mL petroleum ether, then diluted to 500 ppm and 100 ppm. Standard solutions of β-carotene p.a., 5 ppm, 10 ppm, 15 ppm, 20 ppm, 25 ppm, and 30 ppm were made to make the standard curve of β-carotene [10].

Product derived from carrot was produced by destructing 125 gram carrot with 60 ml aquades and then the essence was taken. Then 0.2%(v/v) tween 80, 2.5 gram maltodextrin and 0.0125 gram citric acid were added and shaken until foaming. The foam placed in glass plate then dried at temperature variation 40°C, 50°C, 60°C and 70°C. After the optimum drying temperature acquired, the product derived from carrot was prepared again with foaming agent concentration variation 0.05%(v/v); 0.1%(v/v); 0.2%(v/v) and 0.3%(v/v) and dried at optimum temperature

2.3. UV-Vis Analysis
The acquired carrot powder at every variation of temperature and foaming agent concentration were analysis by spectrometer UV- Vis by diluting 50 mg carrot powder into 25 mL petroleum ether and quantified at maximum wavelength 448.9 nm.

3. Results and Discussion
The Effect of Temperature to β-Carotene Content in Product Derived from Carrot
In this method, tween 80 used as foaming agent in the solution, and maltodextrin used to stabilize the foam so the drying process is fast and β-carotene not destroyed. The variation of drying temperature that used in this research are 40°C, 50°C, 60°C and 70°C with tween 80 concentration 0.2%(v/v). The results shows at Table 1.

| Temperature (°C) | Contained of β-caroten mg/kg | Contained of β-caroten mg/kg average |
|-----------------|------------------------------|-------------------------------------|
| 40              | 3.89                         | 3.9                                 |
| 50              | 10.72                        | 10.55                               |
| 60              | 7.30                         | 8.01                                |
| 70              | 3.87                         | 3.35                                |

And the curve of β-carotene content in sample as a function of temperature can be seen at Figure 1.
Figure 1. The effect of drying temperature to β-carotene content in carrot powder

Table 1 and Figure 1 shows that at temperature 40°C, the β-carotene content in carrot powder is lower than in 50°C. It can be caused by the higher amount of water content in 40°C so there are more micelle that dissolved in water. The higher amount of micelle dissolved in water means lower extracted micelle in petroleum ether so the amount of β-carotene is lower. At 60°C and 70°C, β-carotene content in carrot powder is decreases due to the isomerization of β-carotene. A higher temperature, β-carotene changes from cis to trans configuration. The changes of configuration makes the maximum wavelength shift of β-carotene so it is not quantified at maximum wavelength used.

The β-carotene content also can be seen from the colour of the carrot powder and carrot powder solutions in Figure 2 and Figure 3.

Figure 2. Carrot powder in variations of temperature

Figure 3. Carrot powder solutions in variations of temperature
The Effect of Foaming Agent Concentration to The β-Carotene Content in Product Derived from Carrot

According to the applied temperature in preparation of carrots before, the optimum temperature for drying is 50°C. After the optimum temperature obtained, the carrots preparation to powder was did in various tween 80 concentration. Variation of tween 80 that used are 0.05%(v/v); 0.1%(v/v); 0.2%(v/v) and 0.3%(v/v). The β-carotene content as a function of tween 80 concentration can be seen in Table 2.

Table 2. The β-carotene content in product derived from carrot as a function of tween 80 concentration

| Tween 80 Concentration (v/v) | β-carotene content (mg/kg) | Concentration of β-carotene content (mg/kg) |
|------------------------------|---------------------------|--------------------------------------------|
| 0.05                         | 2.85                      | 2.88                                       |
|                              | 2.66                      | 2.79                                       |
| 0.1                          | 6.92                      | 5.73                                       |
|                              | 7.81                      | 9.12                                       |
| 0.2                          | 10.54                     | 10.42                                      |
|                              | 10.13                     | 10.36                                      |
| 0.3                          | 8.33                      | 7.27                                       |
|                              | 6.6                       | 7.40                                       |

And the curve of β-carotene content in sample as a function of tween 80 concentration can be seen at Figure 4.

Figure 4. The effect of tween 80 concentration of β-carotene content in carrot powder.

According to Figure 4, the optimum tween 80 concentration is 0.2%(v/v). In this concentration, tween 80 has best performance as surfactant. The addition of surfactant in the solution made the surface tension lower. At certain concentration, the surface tension is constant even the concentration increased. The addition of surfactant correspond to the formation of micelle. The concentration when micelle formed is called as critical micelle concentration (CMC). The surface tension is lowering till CMC reached. Then, the surface tension is constant which is shows that the surface is saturated and micelle in dynamic stability with its monomer [11].

According to Attwood and Florence [12], tween 80 is non ionic surfactant that its alkyl side does not have a charge. In this research, tween 80 can lowering the surface tension of carrot essence solutions to form micelle so the β-carotene molecules will trapped in micelle and diluted to medium. The solution becomes foam medium and accelerate the drying process.

β-caroten content is increases at concentration tween 80 0.2%(v/v). It caused by the formation of micelle at the CMC. Nevertheless, the β-caroten content is decreases when the micell concentration adjusted to 0.3%(v/v). This can be understood because at higher concentration, tween 80 becomes
foam destroying agent which decrease the formed foam so β-carotene dilute to the solution. It proved by the colour of carrot powder and the solutions of its powder as can be seen at Figure 5 and Figure 6.

![Figure 5. Carrot powder with variation of tween 80 concentration](image)

**Figure 5.** Carrot powder with variation of tween 80 concentration

![Figure 6. Solution of product derived from carrot with variation of tween 80](image)

**Figure 6.** Solution of product derived from carrot with variation of tween 80

4. **Conclusion**
The results show that the optimum drying temperature is 50°C with β-carotene content 10.55 mg/kg and the optimum concentration of foaming agent (tween 80) is 0.2%(v/v) with β-carotene content 10.36 mg/kg.

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