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THE EFFECT OF ADDITION OF VARIATION DRYING AGENT ON THE CHARACTERISTIC OF RED BEET POWDER (*Beta vulgaris* L) BY SOLAR TUNNEL DRYER (STD)

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ABSTRACT

Healthy natural dyes are needed to produce a good quality and attractive food products. One of the natural red dyes which can be used as a food colorant is red beet (*Beta vulgaris* L). Solar Tunnel Dryer (STD) is one method to produce red beet powder. To improve the quality of dried foods, drying agents (maltodextrin and arabic gum) are commonly applied. This drying agents could speed up the drying process and can also retain the nutrients of products. The purpose of this study is to investigate the effect of drying agent on the physicochemical properties of red beet dried by STD. Physico-chemical properties of red beet powder analyzed were antioxidant activity, moisture content, bulk density, color intensity and wetting ability. Maltodextrin and arabic gum were added in the red beet extract at concentrations of 20%, 40%, and 60%. Red beet extract was adjusted at pH 4. STD was conducted for 200 minutes. The results showed that the use of gum arabic as drying agent with a concentration of 60% had the higher antioxidant activity (90.10%) than that of maltodextrin (79.17%). Moreover, application of 60% arabic gum showed the brighter color (48.22) and higher a* value (22.99) compared to that of maltodextrin. In addition, the highest bulk density of red beet powder (0.721) was achieved by using 60% gum arabic. In conclusion, application of 60% arabic gum is the optimum condition to produce a good quality of red beet powder.

Keywords: *red beet, arabic gum, maltodextrin, Solar Tunnel Dryer*

1. INTRODUCTION

1.1. Background

Currently many food and drink products that use additional food dyes. Color is very important in food industry because it could affect the mind consumers of food products. Food dyes that are used include natural and artificial dyes. Dyes from natural sources is very rare due to the expensive price. In Indonesian, this triggered the use of non-food chemical dyes that are harmful to health like Rhodamin B and Metanil yellow. Both the ingredient is actually coloring matter textil but often used as food coloring since their prices appertain cheap and easily acquired. Data from the *Pengawas Obat dan Makanan* (POM) about extraordinary events (of the Outbreak) food poisoning from 2001-2006 shows an increase in both the number of events or the number of victims who fell ill and died. Nevertheless, the victim dies of suspected might be just 1% only in accordance with the World Health Organization (WHO) estimates. POM data in 5 provinces in 1999-2001 shows that about 89,8% food products contain food additive consisting of 35.6% food products contain boraks, 41.2% contain formalin, 10.4% contain Rodhamin B and 1.9% containing amaran.

To answer that problems is by developing the potential cheap natural dye. Natural pigment of plants get more attention to replacing synthetic dye food coloring which proved to give effect to the human and environmental health. One of the natural Red dyes that can be used as a food coloring derived from Red beet (*Beta vulgaris* L). Beets contain betalain pigments which are complex. These Betalains has attracted to utilized in applicative due to its use as a food coloring and the presence of radical scavenging and antioxidant properties as a protection against the nuisance caused by certain oxidative stress. Pigment color red-purple on beets is derived from betasianin which is called betanin. Beets contain betanin reach 200 mg/100 g. betasianin, like most of betanin in the metabolism of molecules called 3,4-di-hydroxyphenylalanine (L-DOPA).

1.2. Research Purposes

This research aims to know the use of drying agent (Maltodextrin and Gum Arabic) on physicochemical changes n methods of drying using STD including antioxidant activity, moisture content, bulk density, intensity of color and red beet powder wetting ability.

2. MATERIALS AND METHODS

2.1. Materials

The equipment used for the drying of beet red powder are slicer, analytic scales, spoon, measuring cup, a beaker glass, blender, pH meters, moisture balance, spectrophotometer, Chromameter CR-400. The materials used in the manufacture of red beet powder maltodextrin DE 10, gum arabic, ascorbic acid.

2.2. Methods

2.2.1. Sample Preparation

Fresh red beets are separated and washed to clean then peeled the skin. Red beets that have been peeled sliced with uniform thickness using the slicer.

2.2.2. Immersion in Drying Agent

Red beet slices dipped into the drying agent. Drying agent that used was maltodextrin and gum arabic each with a concentration of 20%, 40%, and 60% in aquades. Added Ascorbic acid until the pH reach 4.

2.2.3. Drying with STD

After dipped with drying agent, red beets are styled in the tray that is found in STD. Drying is performed until the red bits moisture content below 10%.

2.3. Analysis

2.3.1. Moisture Content Analysis

Moisture content of red beets each treatment is calculated using moisture balance. Then dried using STD. weight of red beets with analytic scales weighed every 20 minutes to know water levels decrease until it reaches below 10%. Data results weighing heavily red bit is inserted into the formula.

$$\text{Solid Content } 1 = 100 - \text{initial water content}$$

$$\text{Solid Content } 2 = \left(\frac{\text{Solid Content } 1}{100}\right) x\ sample\ weight\ t_0$$

$$\text{Water Content } t_n = \frac{weight\ t_n - solid\ content\ 2}{weight\ t_n}$$

2.3.2. Antioxidant Activity Analysis

Samples about 0,5 grams of red beet powder dissolved in 5 ml of aquades. The sample as much as 0.1 ml is reacted with 3.9 ml solution of DPPH (2,4 mg in 100 ml of methanol DPPH). After it is stored in a dark room for 30 minutes at room temperature and protected with aluminum foil. T then the sample measured using a spektofotometer with a wavelength of 515 nm. DPPH solution standard stored at a temperature of 4^oC and protected with aluminum foil to keep it from the influence of the light effect. The antioxidant activity was calculated as % discoloration by using the formula below:

% = 1 − 30 100% 0

Notes: At_{30} is absorbance at 30 minutes and control absorbance is At_0 (Apriyantono *et al.*, 1989).

2.3.3. Bulk Density Analysis

Bulk density analysis done by inserting samples into a container of known volume to the brim then weighed. Bulk density is measured by comparing the mass of powder sample bit with volume container (bulk). Bulk density is expressed in units of g/cm3 (Sharma et al, 2000).

Weight of material = (weight of the container + material)

Bulk Density = weight of the container volume container

Volume Container = $\pi.R^2.t$

2.3.4. Wetting Ability Analysis

This measurement is used to determine the ease of the powder is moistened expressed in units of seconds. A number of 150 ml water in a glass cup 600 ml wide mouth and closed. As many as 1 gram beetroot powder added to the surface of the water is calm and then records the time formed the starting count since pouring until all the powder is wet (Hartomo & amp; Widiatmoko, 1993).

2.3.5. Color Analysis

Color analysis done using the MINOLTA Chromameter 200 series (CR-200). Chromameter calibrated in advance by firing on a white plate. Once calibrated, chromameter is used to measure the color samples. Red beet powder sample is placed on the clear plastic then measured with a chromameter. Units of color emerges is L *, a *, and b *. L value indicates the level of brightness of the sample, i.e., a value of 0 means the absolute black and 100 means white. The value of b is one attribute that indicates with a scale (-70) to 70. The value of b is negative indicates the degree of bluish while the positive values of b indicates the degree of yellowish. The value of a shows a reddish or greenish sample (Hutching, 1999).

3. RESULTS AND DISCUSSION

3.1. Moisture Content of Red Beet Powder

Table 1. Moisture Content of Red Beet Mixed Maltodekstrin

Time	Control	Maltodextrin 20%	Maltodextrin 40%	Maltodextrin 60%
t-20	79.69 ± 1.30	73.58 ± 0.73	70.81 ± 1.11	67.36 ± 0.80
t-40	73.77 ± 3.10	69.63 ± 0.87	66.71 ± 1.23	62.96 ± 0.82
t-60	67.34 ± 2.99	63.77 ± 1.52	61.22 ± 1.86	57.17 ± 1.11
t-80	59.66 ± 3.36	56.56 ± 1.50	53.77 ± 1.75	49.55 ± 1.20
t-100	46.18 ± 8.34	48.40 ± 1.88	41.75 ± 4.93	37.34 ± 1.80
t-120	33.90 ± 5.87	32.71 ± 1.10	28.47 ± 3.41	22.51 ± 0.59
t-140	26.62 ± 6.23	19.09 ± 2.28	17.57 ± 2.49	11.13 ± 3.14
t-160	17.28 ± 4.79	12.59 ± 2.60	9.47 ± 1.40	7.54 ± 2.05
t-180	12.39 ± 2.46	9.76 ± 2.33	5.54 ± 1.50	4.06 ± 1.27
t-200	9.05 ± 0.41	7.04 ± 1.58	3.26 ± 2.00	2.09 ± 1.59

Description:
All values are the average values ± standard deviation

This research use the drying method of Solar Tunnel Dryer (STD) until the moisture content below 10% and counted the water level every 20 minutes. The temperature recorded during the drying process of red beets are 70±5^{o}C. Test results on the water content of red beets with maltodekstrin contained in table 1, it can be known that drying by using a maltodekstrin 40% and 60% is the quickest drying, but water levels decrease red beets with maltodekstrin 60% is faster.

Table 2. Moisture Content of Red Beets Mixed Gum Arabic

Time	Gum Arabic 20%	Gum Arabic 40%	Gum Arabic 60%
t-20	71.80 ± 1.00	68.99 ± 0.51	66.27 ± 0.12
t-40	68.25 ± 0.93	65.22 ± 0.86	62.54 ± 1.05
t-60	63.83 ± 1.53	60.60 ± 1.48	57.85 ± 1.98
t-80	57.21 ± 1.92	53.62 ± 3.07	51.13 ± 2.99
t-100	46.42 ± 3.79	42.19 ± 5.56	40.40 ± 4.77
t-120	34.11 ± 6.32	29.70 ± 8.34	28.77 ± 7.17
t-140	24.20 ± 2.63	20.19 ± 3.27	19.16 ± 4.18
t-160	17.67 ± 1.54	16.15 ± 2.81	11.80 ± 1.65
t-180	13.14 ± 0.92	9.45 ± 0.28	6.77 ± 1.29
t-200	8.08 ± 0.89	6.22 ± 1.70	4.41 ± 2.38

Description:
All values are the average values ± standard deviation

Based on data of table 1 and 2 about the decrease in moisture content of red beets can be seen that the use of maltodextrin has a faster drying time compared to using gum arabic. This happens because the gum arabic is heteropolimer compact so it can withstand stronger material water. Maltodextrin has a lower molecular weight and molecular structures are much simpler, so that water can easily evaporated when the drying process takes place either in the form of the free water, bound to physically and chemically bound. While at the gum arabic has a higher molecular weight and molecular structure is more complex, there is a large amount of starch in them so that their nature is more hygroscopic and consequently the complex is water on material more difficult evaporated is stuck causing the drying time of red beets to be longer (Dickinson 2003).

3.2. Antioxidant Activity of Red Beet Powder

Table 3. Antioxidant Activity of Red Beet Powder with Drying Agent

Concentration	*% Inhibition*	
	Maltodextrin	Gum Arabic
0%	80.02 ± 2.72^{c}	80.02 ± 2.72^{c}
20%	79.17 ± 4.13^{c}	81.90 ± 4.89^{c}
40%	52.15 ± 3.24^{b}	85.89 ± 3.06^{d}
60%	46.88 ± 2.29^{a}	90.10 ± 0.88^{e}

Description:
1. All values are the average values ± standard deviation
2. Values with different superscript on each line shows that there is a significant difference between the treatment on a confidence level of 95% (<0.05) using test Duncan.

The highest antioxidant found in red beet powder with 0% maltodekstrin or control, while using maltodekstrin can be seen that higher concentration used the lower the % Inhibition or its antioxidant activity. While the use of gum arabic can be known that the use of the concentration of 60% in the real effect on antioxidant activity of red beet powder. Antioxidant activity of red beet powder with gum arabic is so much better than maltodextrin. This happens because the gum arabic can improve stability with increased viscosity. The type of thickener is also heat resistant to process that uses heat but it is better if the heat is controlled to shorten the heating time, given the gum arabic can be degraded slowly and lacked efficiency emulsification and viscosity, so the constituent components of antioxidants like betalain is not damaged by warming.

Decreased antioxidant activity that occurs in the red beet powder added with maltodextrin with the higher concentration, caused by the increasing number of total solids contained in the material is maltodextrin so the total phenolic the less measurable. The level of antioxidant activity in red beet due to the content of phenolic compounds. The content of flavonoids and phenolic acids in red beet is very low (Czapski et al., 2009).

3.3. The Color Red Beet Powder

Table 4. Red Beet Powder Color Using a Drying Agent

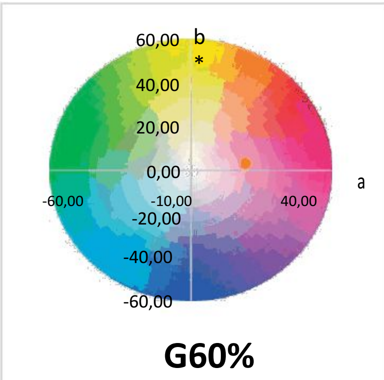
Treatment	Color		
	L*	a*	b*
Control	43.82 ± 0.85^{ab}	14.59 ± 0.98^{a}	3.35 ± 0.15^{b}
Maltodextrin 20%	45.52 ± 1.65^{b}	18.22 ± 0.37^{bc}	3.01 ± 0.32^{ab}
Maltodextrin 40%	43.50 ± 3.79^{ab}	16.44 ± 3.30^{ab}	3.58 ± 0.99^{b}
Maltodextrin 60%	41.42 ± 3.98^{a}	16.02 ± 3.71^{ab}	3.10 ± 0.61^{ab}
Gum Arabic 20%	44.08 ± 1.96^{b}	19.55 ± 2.96^{c}	3.08 ± 1.09^{ab}
Gum Arabic 40%	45.93 ± 2.25^{bc}	20.27 ± 1.94^{c}	2.65 ± 0.32^{a}
Gum Arabic 60%	48.22 ± 1.27^{c}	22.99 ± 0.60^{d}	3.29 ± 0.15^{ab}

Description:
1. All values are the average values ± standard deviation
2. Values with different superscript on each line shows that there is a significant difference between the treatment on a confidence level of 95% (< 0.05) using test Duncan.

The largest value of L* in powder gum Arabic concentration bit with 60% indicating the color of the powder is getting brighter. An a* and b* are also contained on the highest of the powder with a drying agent gum Arabic with a concentration of 60%, this indicates that the color red beet powder tends to be more red compared to using maltodextrin. While the color control powder tends toward dark red color.

The use of drying agents such as maltodextrin and ascorbic acid will lower the pH of the product on the network, so it will inactivate the polyphenol oxidase enzyme that can cause discoloration and decrease in antioxidant activity (Winarno, 2002). The theory is supported by the statements above Sunarmani and Soedibyo (1992), in the manufacture of flour Siam oranges, use the smaller concentrations are 5.0% better than a higher concentration is 7%, due to the higher concentration of filler material, the color products will be further away from the original color.

This causes the brightness of color red beet powder is inversely proportional to the concentration of maltodextrin, which means the higher maltodextrin given as a drying agent, then the color of the powder will be getting darker. Color of maltodextrin is also affect the color of the white pigments. In other words, the color of the products would be further away from the original color. This also causes the color of the powder with a drying agent gum arabic brighter than maltodextrin. A layer of film maltodextrin has the proportion of solids that are higher than those of gum arabic, because of the degree of conversion is lower than the gum arabic (Stephen, 1995).



Figures 1. a* and b* Values of Red Beet Powder with Gum Arabic

3.4. Bulk Density of Red Beet Powder

Table 5. Bulk Density of Red Beet Powder also the effect on the higher concentration of Using Drying Agent drying agent the greater bulk density are also produced.

Concentration	Bulk Density	
	Maltodexrin	Gum Arabic
0%	0.498 ± 0.011^a	0.498 ± 0.011^a
20%	0.549 ± 0.028^b	0.64[illegible] $\pm 0.012^d$
40%	0.571 ± 0.029^{bc}	0.678 ± 0.009^e
60%	0.583 ± 0.028^c	0.721 ± 0.026^f

Description:
1. All values are the average values ± standard deviation
2. Values with different superscript on each line shows that there is a significant difference between the treatment on a confidence level of 95% (< 0.05) using test Duncan.

Based on the observations in the table 5 it can be seen that the use of gum arabic produced powders with bulk density better than using maltodextrin. The addition of gum arabic powder causes a higher bulk density than the bulk density of the powder with the addition of maltodextrin. Maltodextrin film coating solids have a higher proportion than

gum arabic, because the degree of conversion

is lower than gum arabic (Stephen, 1995). Gum arabic is a natural polymer composed mostly of polysaccharides with high molecular weight and contain calcium, magnesium, potassium and high potassium, which produces arabicinose, galactose, glucuronic acid ramnosa and after hydrolysis (Almuslet, et.al, 2012). While maltodextrin is usually distinguished by the value of DE (Dextrose Equivalency). The value indicates multiplicity DE sugar reduction calculated as dekstrosa (Hui, 1992). DE value is inversely proportional to molecular weight, maltodextrin with the lowest score is usually non-hygroscopic whereas DE maltodextrin with higher (lower molecular weight) is hygroscopic. This is

3.5. Red Beet Powder Wetting Capability

Table 6. Red Beer Powder Wetting Capability Using Drying Agent

Concentration	Wetting	
	Maltodextrin	Gum Arabic
0%	46.69 ± 3.89^b	46.69 ± 3.89^b
20%	45.78 ± 8.61^b	61.28 ± 10.50^d
40%	25.98 ± 4.30^a	54.12 ± 2.69^c
60%	20.63 ± 3.55^a	49.73 ± 1.63^{bc}

Description:
1. All values are the average values ± standard deviation
2. Values with different superscript on each line shows that there is a significant difference between the treatment on a confidence level of 95% (< 0.05) using test Duncan.

Measurement of wetting capability aims to determine the solubility of red beet powders produced at different drying agent. The solubility of red beet powder to be applied in determining the ease with which the food product is easily soluble powder would be easy to make and produce texture and good color uniformity. Unlike the other tests, the wetting ability by using maltodextrin having wetting time is faster than using gum arabic. The structure of each granule types of binders are also affecting the solubility of red beet powder. Gum arabic has a molecular structure that is more complex than the maltodextrin, and has a number of starch in it, so the nature of gum arabic is more hygroscopic. Starch re-polymerization process with the help of acid at the time dekstrinisation make maltodextrin molecules are split into smaller sizes with more hygroscopic component, so that when subjected to heating by low pressure, damaged starch particles. As a result of water easily switch to it while releasing components that are easily soluble in water, hence the high solubility (Loksuwan, 2006).

In addition to the mass of powder solubility in water is influenced by the water content of the mass of material that is dissolved. Moisture content of materials of high mass causes a mass of such material becomes difficult to spread or dispersed in water, because the materials tend to be sticky. Thus no pore formed and the mass of the material is not able to absorb large amounts of water. In addition, the mass of material with a higher moisture content has a narrow surface to moistened, because large particle mass so that the sticky side of the particle mass. Solubility level also determines the amount of mass diffusion mass exists in the component materials. The higher the degree of solubility in water then the diffusion components into a mass of material the higher (Straatsma *et al*., 1999). According to McDonald's (1984), maltodextrin has less hygroscopic properties, less sweet, have a high degree of solubility and tend not to form a color reaction browning.

4. CONCLUSION

Drying agent for the manufacture of beet red powder the most optimum use is gum Arabic with a concentration of 60%, which can increase antioxidant activity, the brightness and the color intensity is higher, as well as bulk density is the highest compared to maltodextrin**.** Maltodextrin advantages compared to gum arabic are faster drying time and red beet powder wetting capability increasingly rapidly.

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