# Microencapsulation of Freeze Dried Red Beet Extract with Maltodextrin

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## *Abstract*

*Red beet (Beta vulgaris) extract can be freeze dried to make a natural food colorant powder. Red beet contains betalain that has a role as food colorant. It can also act as food additive to enhance the antioxidant property of product. Microencapsulation is commonly applied to maintain the qualities of dried powder. This research was aimed to produce instant red beet powder by freeze drying with maltodextrin as filling agent and microencapsulated agent. Maltodextrin was added at the concentration of 20%, 40% and 60 % in the red beet extract. Addition of 20% maltodextrin produced the highest qualities of natural colouring red beet powder with the antioxidant activity (32.29 ± 10.57 %), lightness (43.161 ± 2.197), a* value (19.654 ± 0.963) and wet ability (22.63 ± 0.33 second). While three different levels of pH (4, 5, and 6) were applied in the mixture of red beet extract. It was shown that pH 4 could maintain the qualities of red beet powder in term of its health promoting properties. It resulted in the highest scavenging activity which was 94.47 ± 0.76%.*

***Keywords**: freeze drying, reet beet, maltodextrin*

## Introduction

Red beet (*Beta vulgaris*) has potential health benefits due to its antimicrobial, antiviral and anti cancer effects (Strack, Vogt, and Schliemann, 2003). Red beet also has an advantage as a natural colorant. Betalains are pigments in the red beet which have betacyanins (red-violet pigments) and betaxanthins (yellow-orange pigments) (Stintzing and Carle, 2004). These pigments have antioxidant and radical scavenging properties.

Freeze drying is an appropriate process to dry the heat sensitive food stuffs through the main process of freezing and sublimation to remove the water content. Freeze drying is suitable technique for producing the high qualities of red beet powder. It can retain the nutritional value of product because the sublimation or removal of water is conducted at freezing temperature (Singh and Heldman, 2009).

Maltodextrin is a starch hydrolysis product that commonly applied as filling agent and microencapsulated agent. Maltodextrin can be used as encapsulating agent because it has high water solubility, low viscosity, low sugar content, low hygroscopic properties, and strong binding power (Avaltroni *et al*., 2004). Microencapsulation technique has advantages due to its ability to protect and control the release of food ingredients during drying. The stability of red beet pigment is affected by pH and processing temperature. Betalain was thermally sensitive; therefore, addition of maltodextrin could retain this pigment and its antioxidant property.

This research was aimed to produce instant red beet powder by freeze drying with the addition of maltodextrin as filling agent and microencapsulated agent. In addition, this research was purposed to investigate the optimum concentration of maltodextrin and to determine the optimum pH level in producing high qualities of instant red beet powder.

## Materials and Methods

Red beet root was purchased from local market in Semarang, Indonesia. Red beet root was extracted and maltodextrin was added at the concentrations of 20%, 30%, 40% and 60%. Adjusting pH was done at the levels of pH 4, 5 and 6 by addition of ascorbic acid. Then, the mixture was freeze dried for 48 hours until the moisture content of dried product lower than 10%. The dried red beet extract was blended and sieved to get the powder of 80 mesh. The physicochemical characteristics of instant red beet powder were measured (bulk density, wetting ability, colour intensity and antioxidant activity).

The antioxidant activity of red beet powder was analyzed by DPPH method (Ravichandran *et al*., 2013). A control without addition of red beet powder was also analyzed. The absorbance of solution at 515 nm was recorded by using spectrophotometer. The level of antioxidant activity was shown as % inhibition.

Colour intensity was measured by using Minolta chromameter (CR-200) to get three parameters : Lightness (L), a* and b* values.

## Results and Discussion

The effects of maltodextrin on the yield and antioxidant activity of instant red beet powder is shown in Table 1. Higher concentration of maltodextrin produced higher yield and lower antioxidant activity. Maltodextrin has a role as filling agent which increased the yield of products. The optimum maltodextrin concentration that resulted in the highest antioxidant activity was reached at the lowest maltodextrin concentration (20%).

Table 1. Inhibition and yield of instant red beet powder

| Maltodextrin (%) | Inhibition (%) | Yield (%) |
|---|---|---|
| 20 | 44.59 ± 5.05 [c] | 11.68 ± 1.55 |
| 30 | 27.15 ± 1.96 [b] | 16.76 ± 1.33 |
| 40 | 25.17 ± 0.32 [a,b] | 25.06 ± 2.14 |
| 60 | 23.28 ± 0.70 [a] | 39.16 ± 5.11 |

Notes:
- All values are mean ± standard deviation
- Values with different superscript in column show significant differences in the confidence level of α = 0.05

The bulk density and wetting ability of instant red beet powder can be seen in Table 2. Addition of maltodextrin enhanced bulk density and reduced wetting ability of red beet powder. Maltodextrin acts as bulking agent which increases the viscosity and total solid of product. It also has a hydrophilic property and high water solubility (Avaltroni *et al*., 2004). Therefore, higher addition of maltodextrin increased the bulk density of red beet powder.

Table 2. Bulk density and wetting ability of instant dried red beet

| Maltodextrin (%) | Bulk Density ($g/cm^3$) | Wetting ability (second) |
|---|---|---|
| 20 | 0.7958 ± 0.0026[a] | 22.63 ± 0.33 [a] |
| 30 | 0.8040 ± 0.0051[b] | 22.54 ± 0.26 [a] |
| 40 | 0.8245 ± 0.0036[c] | 22.49 ± 0.34 [a] |
| 60 | 0.8305 ± 0.0014[d] | 22.38 ± 0.27 [a] |

Notes:
- All values are mean ± standard deviation

Values with different superscript in column show significant differences in the confidence level of α = 0.05

The stability of betalain is influenced by processing temperature and pH. Table 3 reveals the antioxidant activity and colour intensity of freeze dried red beet powder. Application of 20% maltodextrin at pH 4 resulted in a

dramatically increased of % inhibition (94.47 ± 0.76) compared to those at pH 5 and pH 6. Hence, it can be concluded that maltodextrin was stable at pH 4.

Table 3. Inhibition of instant dried red beet using 20% maltodextrin

| pH | Inhibition (%) | Colour intensity | | |
|---|---|---|---|---|
| | | L | a* | b* |
| 6 | 44.59 ± 5.05 [a] | 43.16 ± 2.20[a] | 19.65 ± 0.96[a] | 1.51 ± 0.07[a] |
| 5 | 47.64 ± 8.96 [a] | 43.48 ± 1.48[a] | 22.40 ± 0.78[b] | 1.23 ± 0.19[b] |
| 4 | 94.47 ± 0.76 [b] | 43.20 ± 1.14[a] | 23.54 ± 0.93[c] | 0.47 ± 0.11[c] |

Notes:
- All values are mean ± standard deviation

Values with different superscript in column show significant differences in the confidence level of α = 0.05

Increasing of % inhibition can be explained by 2 (two) reasons. Firstly, it was due to the addition of ascorbic acid. Ascorbic acid is potential as antioxidant that showing as superior inhibitor for DPPH (Qian and Nihorimbere, 2004). Hence, the antioxidant activity increased. Secondly, red beet pigment was stable at pH 4. This result is supported by Hendry and Houghton (1996) who stated that the the pigment of red beet was stable at pH 4.5.

Figure 1 shows the diagram of colour intensity of instant red beet powder in term of a* and b* values. Application of pH 4 produced the highest a* value with the purplish red colour of red beet powder.

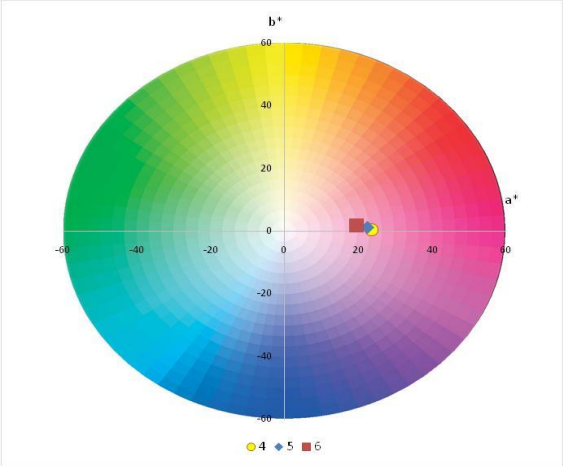


Fig 1. Diagram of colour intensity of instant red beet powder at different level of pH

## Conclusion

Addition of higher concentration of maltodextrin increased yield, bulk density and lightness, but reduced the antioxidant activity of instant red beet powder. Maltodextrin at the concentration of 20% and pH 4 were the optimum condition to produce the highest qualities of instant red beet powder in term of antioxidant property and colour intensity.

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