Characteristics of Chili Powder *(Capsicum Frutescens L.)* with Maltodexstrin Encapsulants from Starch of White Yam *(Dioscorea Alata)*

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Keywords: Encapsulation, Chili Powder, Maltodextrin, White Yam, Arabic Gum.

Abstract: Encapsulation is technique for coating a core in the form of a solid, liquid, gas, or cell active compound with a certain protective material that can reduce the damage to an active compound. Chili is perishable and the capsaicin compounds it contains are volatile. Therefore it is necessary to protect the active compound of capsaicin by encapsulating chili powder. One of the protective materials that can be used in the manufacture of encapsulants is maltodextrin and gum arabic. The purpose of this study was to determine the effect of the addition of maltodextrin from white yam starch and Arabic gum, as well as the addition of chilli powder concentration to the characteristics of the encapsulant produced. The design used in this study was a Completely Randomized Design consisting of two factors. The first factor was the concentration of chili powder (20% and 25%) and the second factor was the proportion of Arabic gum: maltodextrin (70: 30; 80: 20; 90: 10). The results of the best chili powder encapsulation were on the treatment of 25% chilli powder concentration and the proportion of Arabic gum and maltodextrin (90: 10) with a moisture content of 4.174%; Trapped Capsaicin 1.781 mg / gr; Capsaicin Total 2.764 mg / gr; encapsulation efficiency of 64.436%; loading capacity27.640 mg / gr; color L 49.30; color a 32.95; color b 29.60 which is red.

1 INTRODUCTION

Chili has the active compound of capsaicin which has a spicy taste (Borges, 2001). Capsaicin can be used as an inhibitor of leukemia cancer (Ito, 2002), prostate cancer (Mori, 2006), and diabetes (Razavi, 2006). But chili is perishable and the capsaicin compounds it contains are volatile. Therefore it is necessary to take action to protect the active compound capsaicin. Post-harvest processing technology that can be done is encapsulation.

The coating material commonly used as encapsulant from gum, carbohydrates, and proteins such as skim milk, lactose, sucrose, maltodextrin, alginate, arabic gum, starch, agar, gelatin, carrageenan, albumin, and casein. Encapsulation aims to protect active ingredients that are sensitive to damage due to oxidation, loss of nutrients, protect flavor, aroma, pigment, and increase solubility. For water-soluble materials, the encapsulation method has great potential to convert unstable liquids into powders that are easier to handle and easily mixed in dry food systems (Versich, 2000). Maltodextrin can be produced from modified starch. Starch is found in many tubers. One of the tubers that has not been widely used is the tubers of white yam (*Dioscorea alata)*.

Maltodextrin has a variety of functions including enlargement and film forming properties, the ability to bind to taste and fat, and reduce the oxygen permeability in the wall matrix. Some of the reasons underlying maltodextrin for encapsulation materials are: maltodextrin can reduce the reactivity of the core material with the environment, controlled release suitable for the core ingredients of drugs, maltodextrin can improve the process and texture, maltodextrin can strengthen solubility (Bae et al., 2008). Maltodextrin with low DE (Dextrose Equivalene) is non-hygroscopic, whereas maltodextrin with high DE tends to absorb water (hygroscopic) (Blancard, 1995).

Kunarto (2017) research the Dextrose Equivalen (DE) value of durian starch maltodextrin ranges between 8.33-13.42. At 25-50 minutes hydrolysis

Rosida, D., Dewi, A. and Elianarni, D.
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DOI: 10.5220/0009984100002964
In *Proceedings of the 16th ASEAN Food Conference (16th AFC 2019) - Outlook and Opportunities of Food Technology and Culinary for Tourism Industry*, pages 19-25
ISBN: 978-989-758-467-1

there was no increase in DE value, but hydrolysis of more than 50 minutes showed an increase in DE value because the breakdown of starch would further facilitate the hydrolysis of glycosidic bonds. Sajjaanakantakul and Mukprasirt (2004) stated that the longer the hydrolysis, the longer the α-amylase contact with starch so that more monomers-mononers can be hydrolyzed by enzymes.

In the research of Sukatiningsih (2011) the form of antioxidant capsules with Arabic gum capsules substituted with modified starch (90:10) 25% core material. In the study of Purwaningsih et al (2013), maltodextrin and gum coatings were used as matrix forming the microcapsule wall. This matrix network is important in the wall system, with good maltodextrin matrix tissue properties in the wall system and also good gum properties in forming the film layer, the extract conditions can still be maintained. For that reason, in this study we want to know the characteristics of chili powder encapsulation using maltodextrin from starch of yam and arabic gum.

2 METHODOLOGY

2.1 The Making of Maltodextrin of White Yam

A total of 1 kg of white yam flour was added with 2 L of water, then filtered. White yam paste was mixed with 2 L of water and refined. The filtrate obtained was then deposited for 12 hours. The obtained starch was then dried at 50 ° C for 6 hours, then grind and sieved (80 mesh) to obtain fine starch flour.

A total of 20 grams of dried starch was dissolved into 100 ml distilled water containing $CaCl_2$ 200 ppm, then added 0.1 N NaOH to pH 7. A 0.09% α-amylase enzyme was added to the starch suspension of 0.1 mL. The starch suspension was hydrolyzed by enzymes in the waterbath shaker, for 120 minutes at 40ºC. The starch suspension was cooled to 30 ºC. Then the addition of 0.1 N HCl to pH 4, then heated in boiling water to stop the enzyme activity. 0.1N NaOH reagent was added to reach the pH range of 5. Washing was carried out to remove residual chemical residues added in the process. The results obtained were dried at 50 ºC. for 6 hours, then smoothed and sieved with an 80 mesh sieve.

2.2 Procedure for Making Chili Powder

Chili were weighed and sorted, washed and cleaned. The chili was dried at 50ºC for 6 hours. Chili dry was then mashed and sieved using an 80 mesh sieve, until a fine chili powder was obtained.

2.3 Procedure for Making Rawite Chili Powder Encapsulation

Encapsulan was made from Arabic gum and maltodextrin with proportions of 70: 30; 80: 20; 90: 10. Chili powder and encapsulan (50 gr) are added in proportions of 20% and 25%, then dissolved in 100 ml of distilled water 50℃. The mixture of materials was homogenized with a magnetic stirer for 10 minutes. The results obtained were then dried at 50 ºC. for 6 hours, then smoothed and sieved with an 80 mesh sieve.

3 RESULTS AND DISCUSSION

The analysis resulted of raw chili powder including water content, yield, solubility, dextrose equivalent and color in chili powder, starch and white yam maltodextrin can be seen in Table 1.

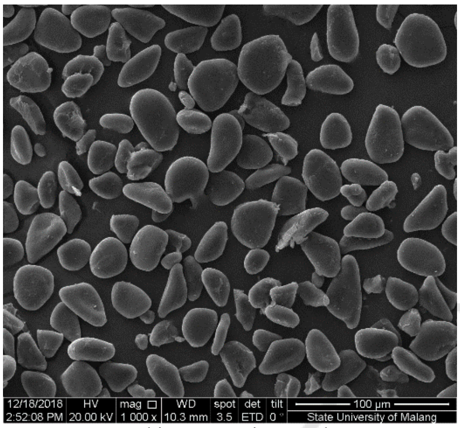
3.1 Trapped Capsaisin and Total Capsaisin of Chili Powder Encapsulation

Trapped Capsaisin (KE) is a capsaicin that is trapped in a capsule. Capsaicin trapped is the amount of capsaicin found in encapsulants. Products with high trapped capsaicin show that capsaicin can be well protected by a protective matrix. In Figure 1. Showed the higher concentration of Chili and the higher proportion of Arabic gum or the lower proportion of maltodextrin, the trapped capsaicin encapsulation of chili powder increased.

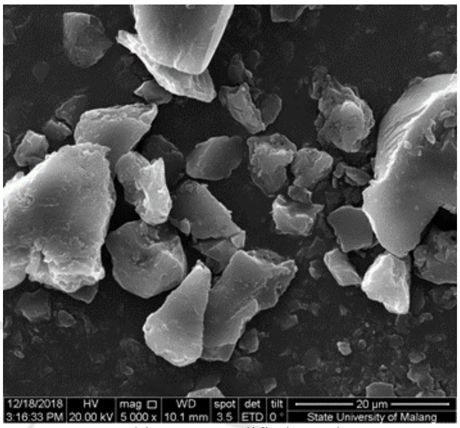
In the treatment of 25% chili powder concentration and the proportion of arabic gum and maltodextrin (90:10), the highest mean value of Trapped Capsaisin encapsulation was 1.781 mg / gr. whereas in the treatment of 20% chili powder concentration and the proportion of arabic gum and maltodextrin (70:30) had the lowest trapped capsaisin encapsulation value of 1.263 mg / g. The relationship between the treatment of chili powder concentration and the proportion of arabic gum and maltodextrin was shown in Figure 1.

Table 1: Result of raw material analysis.

Parameter	Chili Powder	White yam Starch	White yam Maltodextrin
Water (%)	5.463 ± 0.173	5.575 ± 0.147	5.416 ± 0.070
Yield (%)	23.936 ± 0.195	6.946 ± 0.148	98.417 ± 0.362
Solubility (%)	-	-	99.131 ± 0.227
D*extrose Equivalen*	-	-	9.861 ± 0.196
Colour	L 42.90 ± 0,141 a 33.25 ± 0,071 b 30.65 ± 0,071	_	_



White yam native starch



White yam modified starch

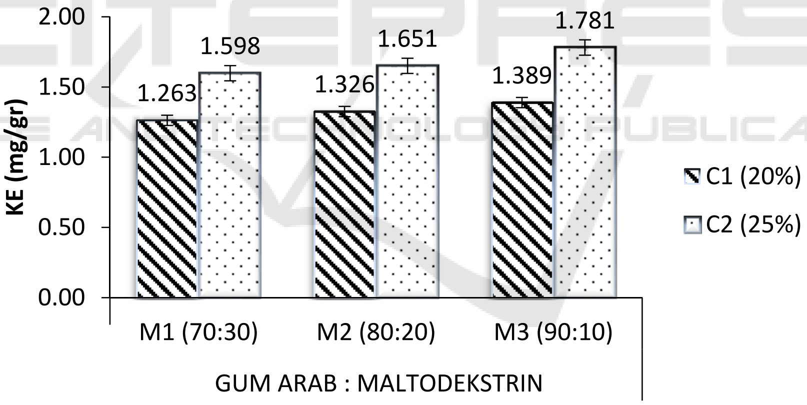


Figure 1: Histogram of KE (trapped capsaisin) values on encapsulation of chili powder.

This is due to the ability of Arabic gum to increase the viscosity of a solution. High viscosity during the drying process will make the skin layer formed firmly so that the core material will be protected, and the presence of maltodextrin combined with Arabic gum will improve the quality of encapsulants formed because maltodextrin has a small size so that it can cover the pores of encapsulant and maltodextrin also has plastic properties that work to prevent the cracking of the protective matrix.

This is supported by Lin et al., (2009) that more and more core materials are encapsulated with increasing concentrations of added core ingredients. Gharsallaoui et al, (2010) maltodextrin influences the quality of the encapsulant produced because maltodextrin has a smaller size compared to Arabic gum, so that it can cover the pores of the encapsulant and reduce the amount of core material that comes out of the encapsulant. Ton et al. (2016) the combination of maltodextrin and arabic gum as a coating material can increase stability and better protection of the core material.

In the treatment of 25% chili powder concentration and the proportion of Arabic gum and

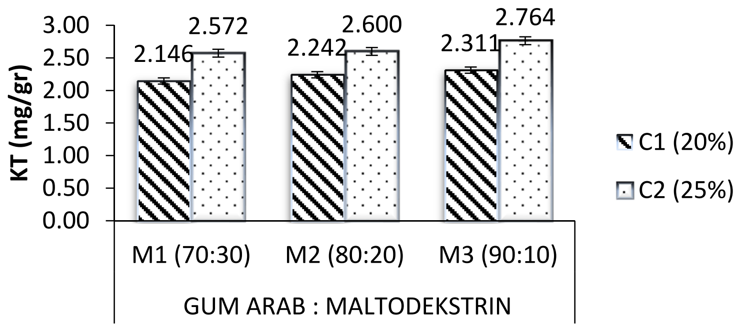


Figure 2: Histogram KT (Total capsicin) value on encapsulant of chili powder.

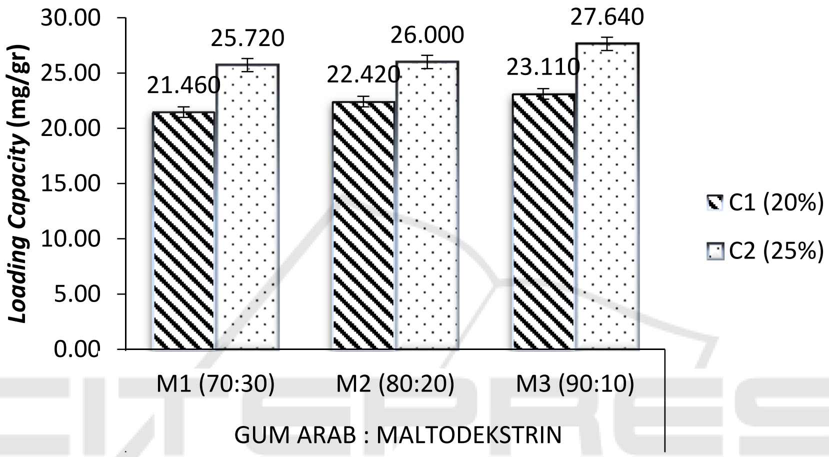


Figure 3: Histogram loading capacity of encapsulation of chili powder.

maltodextrin (90:10) had the highest average encapsulant KT value of 2.764 mg / gr. Whereas in the treatment of 20% chili powder concentration and the proportion of Arabic gum and maltodextrin (70:30) had the lowest mean encapsulant KT value of 2.146 mg / g. The relationship between the treatment of chili powder concentration and the proportion of Arabic gum and maltodextrin was shown in Figure 2.

KT is total capsaicin, i.e. the amount of capsaicin found in encapsulants, both inside and outside the encapsulated surface. In Figure 2. Showed the higher concentration of the addition of chili powder and the higher proportion of Arabic gum or the lower maltodextrin, the total capsaicin (KT) of chili powder encapsulation increased. This was due to the higher concentration of chili powder added, so that the total capsaicin also be higher.

3.2 Loading Capacity (LC)

In the treatment of 25% chili powder concentration and the proportion of Arabic gum and maltodextrin (90:10) has the highest loading capacity value of 27.640 mg / gr. Treatment of 20% chili powder concentration and proportion of Arabic gum and maltodextrin (70: 30) had the lowest average loading capacity, which was 21.460 mg / gr. The relationship between the treatment of cayenne powder concentration and the proportion of arabic gum and maltodextrin was shown in Figure 3.

Loading capacity was the amount of total capsaicin in the encapsulant which is calculated based on the ratio of the total active ingredients in the encapsulant to the overall encapsulant weight. Figure 3. Showed the higher concentration of the addition of chili powder and the higher proportion of Arabic gum or the lower maltodextrin, the loading capacity of chili powder encapsulation increased. This was due to the higher concentration of chili powder added, so that the capsaicin contained in the encapsulant also increased.

In addition to the addition of chili powder, Arabic gum and maltodextrin also influence the increase in loading capacity. Arabic gum has the ability to increase the viscosity of a solution. High viscosity during the drying process make the skin layer formed

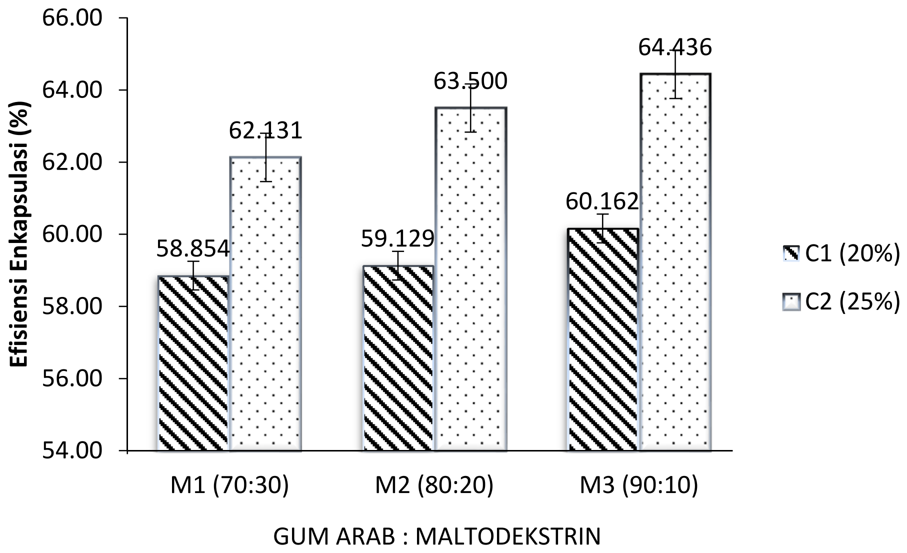


Figure 4: Histogram of the encapsulation efficiency on chili powder encapsulation.

firmly so that the core material be protected, and the presence of maltodextrin combined with Arabic gum improve the quality of encapsulants formed because maltodextrin has a small size so that it can cover the pores of encapsulant and maltodextrin also has plastic properties that work to prevent the cracking of the protective matrix.

Syamsir (2013) states that maltodextrin also has good plastic properties so that it can prevent cracking of the protective matrix. Ton et al. (2016) researh the combination of maltodextrin and arabic gum as a coating material can increase stability and better protection of the core material. Krishnan et al., (2005) state the encapsulant wall layer is very influential on the amount of core material produced, the addition of arabic gum can affect the thickness of an encapsulant wall, the more robust an encapsulant wall layer cause the core material contained in the encapsulant to be well protected .

3.3 Encapsulation Efficiency (EE)

Treatment of 25% chili concentration and proportion of Arabic gum and maltodextrin (90:10) had the highest average value of encapsulation efficiency of 64.436%. Whereas in the treatment of 20% chili powder concentration and the proportion of arab gum and maltodextrin (70: 30) had the lowest average encapsulation efficiency value of 58.854%. The relationship between the treatment of chili powder concentration and the proportion of Arabic gum and maltodextrin was shown in Figure 4.

Encapsulation efficiency is used to determine the success rate of the encapsulation process. The efficiency referred to in this study is the comparison between trapped capsaicin and total capsaicin. The higher the encapsulation efficiency means the better the coating's ability to protect its core material. Based on Figure 4. Showed the higher concentration of chili powder and the higher proportion of Arabic gum or the lower proportion of maltodextrin, the encapsulation efficiency of chili powder increased. This was due to the higher concentration of chili powder added, so that the capsaicin contained in the encapsulant also increased. In addition of chili powder, arabic gum and maltodextrin also influence the increase in encapsulation efficiency. Arabic gum has the ability to increase the viscosity of a solution. High viscosity during the drying process will make the skin layer formed firmly so that the core material can be well protected, and the presence of maltodextrin combined with Arabic gum will improve the quality of the encapsulants formed because maltodextrin has a small size so that it can cover the pores of the encapsulant and Maltodextrin also has plastic properties which function to prevent the cracking of the protective matrix.

This is supported by the statement of Mcnamee et al., (2002) that Arabic gum has the ability to form a strong protective matrix around the core material, resulting in a higher encapsulation efficiency value by increasing the concentration of arabic gum in the coating material. The mechanism of retention of the active substance in the capsule during the drying process is a film layer formed on the surface of the droplet. This film is more permeable to water molecules that act as solvents as long as the solid is dried and the pore size is smaller than the molecules of the active substance. Because active substance molecules have lower solubility and are larger in size than water molecules, active molecules cannot diffuse out through the surface of the film and are trapped in dry droplets (Supriyadi et al., 2013). Young et al. (1993) explain that the encapsulation efficiency is higher with an increase in the core material. Frascareli et al. (2012) also states that one of the factors that influence the efficiency of encapsulation is the concentration of core material. The higher concentration of core material, it cause high viscosity, high viscosity will increase the efficiency of encapsulation. The same results were obtained from research conducted by Minemoto et al. (2002), where the increased core weight increases the value of the encapsulation efficiency.

3.4 Color Intensity

On the results of the analysis of raw materials of chili powder obtained color intensity L 42.90. The L encapsulant value of chili powder was greater than the raw material that is 49.90-51.22. The intensity of the color L indicates lightness or brightness where the range of numbers is from 0 to 100. The smaller or closer to 0, it means that the material display darker colors and the higher the number up to 100 will display brighter colors (Hutchings, 1999).

In Table 2. Showed that the higher the concentration of chili powder, the lower the color intensity of the L encapsulant value of chili powder. This was due to the increasing concentration of chili powder increased the red pigment in the encapsule. This is supported by the research of Maryanto and Yuwanti (2005) that the higher the level of solids in a solution cause more colors to be absorbed than what is transmitted so that the color will look concentrated and the higher the core material added will increase the color pigment in the product.

Table 2: The value of encapsulant color intensity with the treatment of chili powder concentration.

Concentration of Chili Powder (%)	L Value	A value	B value
20	51.22^{b}	30.48^{a}	27.68^{a}
25	49.90^{a}	31.85^{b}	28.97^{b}

Note: The average value followed by the same letter means that it is not significantly different ($p < 0.05$).

In Table 3. Showed that the higher the proportion of Arabic gum or the lower proportion of maltodextrin, the color intensity of the L encapsulant of chili powder decreased. This was because arabic gum has a slightly darker white color while maltodextrin has a yellowish white color. This is supported by the statement of Blanchard et al., (1995) that Arabic gum and maltodextrin have different base colors. Arabic gum has a rather dark white color while maltodextrin has a yellowish white color. Therefore the greater the addition of arabic gum the encapsulant color gets darker, while the addition of large maltodextrin causes the intensity of the lightness color to be brighter.

Table 3: The value of encapsulant color intensity by the treatment of Arabic gum and maltodextrin proportions.

Proportion Gum : Maltodekstrin (%)	L Value	A value	B value
70 : 30	51.03^{c}	30.25^{a}	27.73^{a}
80 : 20	50.58^{ab}	31.23^{b}	28.40^{b}
90 : 10	50.08^{a}	32.03^{b}	28.85^{b}

Note: The average value followed by the same letter means that it is not significantly different ($p < 0.05$)

The more the addition of Arabic gum proportion or the lower the addition of maltodextrin, the color intensification of the value of increase. This is because Arabic gum has a rather dark white color, while maltodextrin has a yellowish white color. Therefore, the greater the addition of gum arabic encapsulant chilli color, proclaim the more concentrated.

The results of the analysis of raw chili obtained the value of b 30.65. The encapsulant value of chili powder has a lower value compared to the raw material that is 27.68-28.97. The value of b in the color intensity shows yellow - blue. The yellow color ranges from 0 to +100 while the blue color ranges from 0 to -80. The greater the positive value b indicates yellow while if the negative value is higher it indicates blue (Hutchings, 1999). The higher the concentration of chili, the higher the color intensity of the encapsulant of chili. This is due to the increasing concentration of chili will increase the red pigment in the encapsule.

4 CONCLUSION

Capsaisin in chili (*Capsicum frutescens L.*) needs to be protected by the encapsulation process. The coating material commonly used as encapsulant is maltodextrin and arabic gum. Maltodextrin is often produced from cassava. In this researches of maltodextrin from white yam (*Dioscorea alata*). The best treatment was obtained using 25% chili powder concentration and the proportion of arabic gum and maltodextrin (90:10) which produced a characteristic water content of 4.174%; trapped capsaisin 1.781 mg / gr; capsaicin total 2.764 mg / gr; encapsulation efficiency 64.436%; loading capacity 27.640 mg / gr; with a color value of L 49.30; a 32.95; b 29.60 (red).

ACKNOWLEDGEMENT

Our gratitude goes to the Ministry of RISTEKDIKTI for providing funding to Based Research scheme as well as to the LPPM UPN Veteran Jawa Timur, Indonesia who have facilitated this activity a lot.

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