



Characterization and Optimization of Natural Maltodextrin-based Niosome

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ABSTRACT

Natural maltodextrin, due to their outstanding merits, have received more and more attention in the field of drug delivery systems. In particular, maltodextrin seem to be the most promising materials in the preparation of niosome carriers. This study aimed to optimize and characterize the formulation of natural maltodextrin-based niosome. The natural maltodextrin was made from cilembu sweet potato starch which used partial starch hydrolysis method by α -amylase enzyme. Proniosome and niosome formulations used three various concentration of surfactant (sorbitan monostearat) which about 5 mmol, 7.5 mmol, and 10 mmol for formula 1 (F1), formula 2 (F2), and Formula 3 (F3) respectively. In addition, physical and chemical characterizations had been done to characterize maltodextrin, proniosome, and niosome. The Dextrose Equivalent (DE) value of natural maltodextrin was 7.99 ± 0.11 . Furthermore, the vesicle size of proniosome was in the range of 5μ to 13μ . The entrapment percentages of piroxicam in niosome formulations were $72.5 \pm 1.1\%$, $76 \pm 1.7\%$, and $77.5 \pm 1.9\%$ for F1, F2 and F3 respectively. It can be concluded that the result provided an indication of natural maltodextrin from Cilembu sweet potato starch are potential carrier in the proniosome preparation which can be used for producing niosomes.

INTRODUCTION

Piroxicam, one of the non-steroid anti-inflammatory drug (NSAID) as a model in this study, have been formulated into topical delivery to avoid its side effect (Wathoni, 2012). However, the passive transport of piroxicam across mammalian skin is relatively low (Doliwa, 2012). On other hand, niosome formulation can be used to improve the rate of penetration of active substance by transdermal drug delivery (Blazek-Welsh *et al*, 2001). Niosomes are non-ionic surfactant vesicles and obtained on hydration of synthetic nonionic surfactants, with or with out incorporation of cholesterol or other lipids (Tangri and Khurana, 2011). The study of erythromycin with using niosome formulations proved that it can improve diffusion rate of erythromycin in transdermal drug delivery (Jayraman, 1996). Other studies reported that the formulation and evaluation of Indomethacin loaded niosomes showed therapeutic effectiveness increased and simultaneously toxic side effect reduced as

compared with free Indomethacin in paw-oedema bearing rats (Namdeo *et al*, 1999). The methods of manufacturing niosome has some draw backs nowadays, such as need a complex preparation, long time and special equipments. This problem can be solved with the establishment of proniosome (Lian, 2001). Blazek-Walsh *et al*., have reported the formulation of niosomes from maltodextrin based proniosomes. This provides rapid reconstitution of niosomes with minimal residual carrier. Slurry of maltodextrin and surfactant was dried to form a free-flowing powder, which could be rehydrated by addition of warm water (Blazek-Welsh *et al*, 2001).

Jufri study also showed that maltodextrin, Dextrose Equivalent 5-10 and was derived from cassava starch, can be used as a base material of niosome (Jufri, 2004). In this study maltodextrin derived from Cilembu sweet potato starch (*Ipomoea batatas* sp.) which has a high starch content (Arifin, 2002).

MATERIAL AND METHODS

Cilembu sweet potato starch (*Ipomoea batatas* sp.) were obtained from Sumedang (West Java Province-Indonesia), α -amilase enzyme (sigma aldrich), all other reagents used were of analytical grade.

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Preparation of Maltodextrin

The early stages of niosome preparation was to make maltodextrin which was derived from the manufacture of starch Cilembu sweet potato (*Ipomoea batatas* sp). The method of maltodextrin preparation was modified according to the method described by Griffin and Brooks (1989).

Preparation of Proniosome

The preparation of proniosome was adopted and modified from Blazek-Welsh and Rhodes study with "slurry method" (2001). Maltodextrin-based proniosome was made by coating with a non-ionic surfactant, sorbitan monostearate or span 60, with various concentrations for each formula.

Table. 1: Formulation of proniosome with variation of surfactant (n=3).

Formula	Total weight(gr)	Span 60(mmol)
F1	5	5
F2	5	7,5
F3	5	10

Preparation of Niosome

The stock solution of piroxicam was made with a concentration of 20 ppm in a mixture of ethanol and triethanolamine. Niosome was made by carefully weighing the amount of proniosome powder then inserted into a test tube. Piroxicam solution was heated to $\pm 80^\circ\text{C}$ and added to the test tube. Once sealed, the mixture was blended with a vortex mixer (Thermalyne type 16700 mixer) for ± 30 seconds (repeat 4x). The preparation obtained was cooled at room temperature (Jufri, 2004).

Characterization of maltodextrin, proniosome, and niosome

The pH of the solutions was recorded using a digital pH meter (Methrom 744). The organoleptic (Reynolds, 1993), water contents, repose angle, compressibility index, and density in the samples were determined according to standard methods (Lachman and Lieberman, 1995). The reducing sugars were estimated by the method of Somogyi and expressed as the dextrose-equivalent value (Nelson, 1944).

Particle Size Analysis

Characterization of proniosome with a scanning electronic microscope (Labphot-2 Nikon AFX-DX) was done by comparing the formula between the highest and the lowest concentration of surfactant. Proniosome formulas were seen under an electron microscope with a magnification of 1000x, 10000 and 15000x to observe the size, shape and surface morphology analysis of the molecule.

Estimation of drug entrapment efficiency

For determination of the drug content, the suspension of niosome (1.0 mL) was diluted with water (1:4) and centrifuged at 4000 rpm for 30 min (Jufri, 2004), the solution was filtered, 1 ml of the filtrate was pipetted out and diluted to 10 ml and analyzed

for the drug content using Specord 200 (analytic jena) UV Visible spectrophotometer at 353 nm. The drug content was computed using a calibration curve ($R^2 = 0.9987$) prepared using solutions with concentrations of 2 to 14 mg/mL of piroxicam. The drug entrapment efficiency was calculated using the following formula:

$$\% \text{ drug entrapment efficiency} = \text{Practical drug content} / \text{Theoretical drug content} \times 100$$

RESULTS AND DISCUSSION

Characterization of maltodextrin

Preparation of maltodextrin with partial starch hydrolysis method by α -amylase enzyme for 100 minutes produced the DE value of maltodextrin about 7.99 ± 0.11 . It was obtained by entering values of sample absorbance to standard curve of anhydrous glucose.

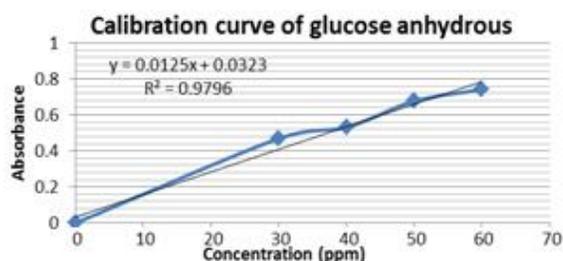


Fig. 1: Calibration curve of glucose anhydrous.

Maltodextrin which was made with a 150-minute incubation time had a value of DE greater than maltodextrin with a second manufacturing conditions. This is caused by enzyme α -amylase which can break the amylose is an enzyme that can break the ties amylolytic α -1, 4 glycoside on starch molecules randomly. The longer the process of hydrolysis of the bond, the more α -1, 4 glycoside of starch being broken by the enzyme α -amylase. The more bonds break, the greater the value of DE. High DE value increased hygroscopicity, color, and taste sweet. The study of maltodextrin characterization showed that all the results were qualify with the reference.

Table. 2: Measurement of DE.

Enzym (%)	T ($^\circ\text{C}$)	t (min)	Sugar reduction* (%)	Water content*	DE*
0.25	65	150	$1.35 \pm 0.2\%$	$9.06 \pm 0.32\%$	14.92 ± 0.5
0.25	65	100	$0.74 \pm 0.12\%$	$9.26 \pm 0.22\%$	7.99 ± 0.11

*Data are expressed as mean \pm SD. n = 3.

Table. 3: Characterization of Maltodextrin.

Characterization	Reference (Martindele,1993)	Result*
Organoleptic		
1. Form	Powder	Powder
2. Color	Yellowish white	White
3. Smell	Malt smell	Malt smell
4. Taste	No taste	No taste
Water content (%)	> 6	9.26 ± 0.3
pH	4-7	6.89 ± 0.4
Repose angle ($^\circ$)	-	7.6 ± 0.3
Compressibility index(%)	-	27.78 ± 1.6
Density (gram/ml)	-	0.6 ± 0.1

*Data are expressed as mean \pm SD. n = 3.

Characterization of Proniosome

The results on the water content of each formulas were $8.37 \pm 0.3\%$ for formula 1, $8.67 \pm 0.1\%$ for formula 2, and $8.76 \pm 0.1\%$ for the formula 3. This difference is caused by differences in the use of surfactant concentration for each formula. The more surfactant is added, the higher the water content. Proniosome less resistant to room temperature because of its low melting point. The pH test results showed a decrease compared with the results of pH maltodextrin. The decline was due to the addition of chloroform during the coating process. Chloroform (CHCl₃) has a group that is electron-withdrawing Cl when in aliphatic structures, so as to increase the acidity.

Table 3: Characterization of Proniosome.

Characterization	Formula 1*	Formula 2*	Formula 3*
Organoleptic			
a. Form	Powder	powder	powder
b. Color	Yellowish white	Yellowish white	Yellowish white
c. Smell	No smell	No smell	No smell
Water content (%)	8.37 ± 0.3	8.67 ± 0.1	8.76 ± 0.1
pH	6.08 ± 0.2	6.07 ± 0.1	6.09 ± 0.3
Repose angle (°)	27 ± 1.0	28 ± 1.1	30 ± 1.2
Compressibility index (%)	50 ± 2.1	55 ± 1.5	56.5 ± 1.1
Density (gram/ml)	0.75 ± 0.3	0.78 ± 0.3	0.80 ± 0.3

*Data are expressed as mean \pm SD. n = 3

The results of repose angle study, compressibility index and density in proniosome formulas were greater than maltodextrin. Moreover, the addition of surfactant, the greater number of the surfactant, the surface will be more rough and also causing increased repose angle, compressibility and density. In general, the repose angle of proniosome and maltodextrin showed good flow properties of powders ie between 25-45° (Blazek-Rhodes 2001). On the other hand, the compressibility index in proniosome formulas was bad.

Particle Size Analysis

From the microscopy test results, the small particles were not uniform in size. It can be seen from the figure that the resulting particles have a diameter variation vesicles ranging from 5μ to 13μ . This shows that the resulting proniosome included in microparticles.

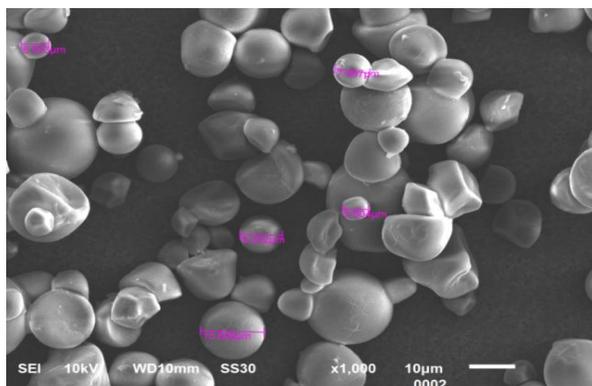


Fig. 2: Proniosome formula 1 (magnification of 1000x).

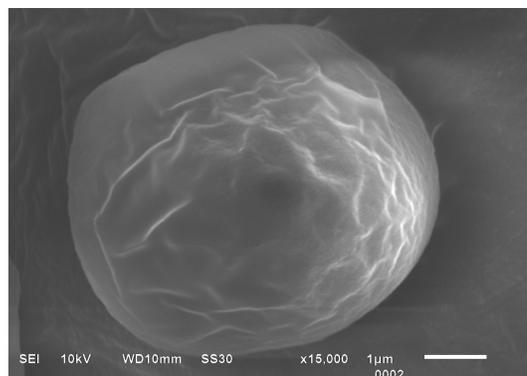


Fig. 3: Proniosome formula 1 (magnification of 15000x).

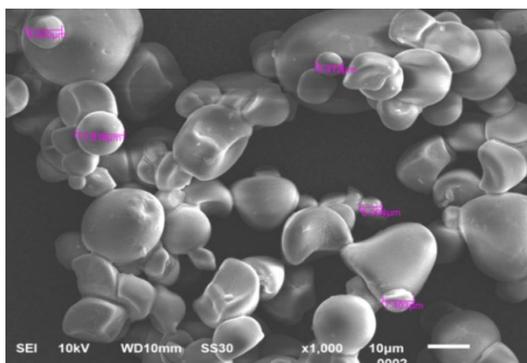


Fig. 4: Proniosome formula 3 (magnification of 1000x).

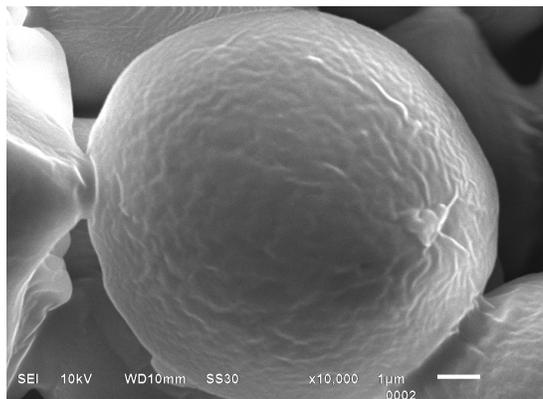
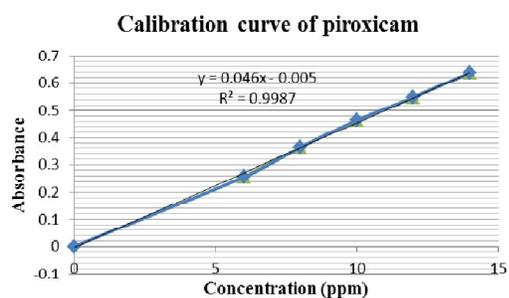


Fig. 5: Proniosome formula 3 (magnification of 10000x).

There are differences in figure 2 and figure 4. In picture 2 smoother surface than in figure 4. It can be caused by high surfactant concentration. Higher surfactant concentration causes a rougher surface and thicker vesicle walls. On the other hand, the surface of the vesicles in figure 3 appeared to have more wrinkles than the vesicles in Fig 5. The higher concentration of surfactant vesicles would tend to be more resistant to environmental disturbances.

Estimation of drug entrapment efficiency

The amount of surfactant in the formula 3 which was higher than others formulas can entrap the drug better than others formulas. Although it can not reach optimal conditions as expected, it can be pointed out that the more use proniosomes the more drugs that can be snared.

**Table 4:** Percentage of entrapment drug.

F	Weight	Total Piroxicam (ppm)	Piroxicam in solution (ppm)*	Entrapment percentage (%)*
1	1	20	5,5±0.3	72,5±1.1
2	1	20	4,8±0.2	76±1.9
3	1	20	4,5±0.3	77,5±1.7

*Data are expressed as mean ±SD. n = 3

CONCLUSION

It can be concluded that the maltodextrin which was derived from Cilembu sweet potato starch had a Dextrose Equivalent (DE) 7.99±0.11 and provided an indication as potentially carrier in the proniosome preparation which can be used for producing niosomes. Niosom formula 3 was the best and most effective as it can entrap piroxicam with the highest level ie 77.5 ±1.7%.

REFERENCES

- Arifin M. Pedon characterization of sweet potato cropping area nirkum Cilembu Village, District Tanjungsari, Sumedang Regency, West Java. *Jurnal Agrikultura*, 2002; 13(2): 110 –116.
- Blazek-Welsh AI, Rhodes DG. Maltodextrin Based Proniosomes, *AAPS Pharm Sci*, 2001; 3(1):1-8.

Doliwa A, Santoyo S, Ygartua P. Effect of Passive and Iontophoretic Skin Pretreatment with Terpenes on the In Vitro Skin Transport of Piroxicam. *Int J pharm*, 2001; 229 (1-2):37-44.

Griffin VK and Brooks JR. Production and Size Distribution of Rice Maltodextrin Hydrolyzed from Milled Rice Flour Using Heat Stable Alpha Amylase. *Journal of Food Science*, 1989; 54(1): 190-193.

Jufri M, Anwar E, Djajadisastra J. Preparation of Maltodextrin DE 5-10 Based Niosome From Cassava Starch, *Majalah Ilmu Kefarmasian*, 2004; 1(1): 10-20.

Lachman L and Lieberman HA. 1994. *Theory and Practice of Industry Pharmacy*, Translated by Siti Suyatmi, Jakarta: UI Press, 111, 142, 146-147, 339-357.

Lian T, Rodney JY. Ho. Trends and Developments in Liposome Drug Delivery Systems. *Journal of Pharmaceutical Sciences*, 2001; 90 (6): 667-680.

Namdeo A, Mishra PR, Khopade AJ and Jain NK. Formulation and evaluation of niosome encapsulated indomethacin. *Indian Drugs*, 1999; 36(6): 378-380.

Nelson N. A photometric adaptation of the Somogyi method for the determination of glucose. *J. Biol. Chem*, 1944; 153: 375-380.

Pranshu T, Shaffi K. Niosomes: Formulation and Evaluation. *Int J Biopharm*, 2011; 2(1): 47-53.

Reynolds JEF. 1993. *Martindale: The Extra Pharmacopeia*, Volume 1. Singapore: Info Access & Distribution Pte Ltd, 1044.

Uchegbu IF and Vyas SP. Non-ionic Surfactant Based Vesicles (Niosomes) in Drug Delivery. *Int J Pharm*, 1998; 172: 33-70.

Wathoni N, Pamudji JS, Darijanto S. Effect of Iontophoresis and Penetration Enhancers on the In Vitro Diffusion of a Piroxicam Gel. *Int J Pharm Pharm Scie*, 2012; 4(4):215-218.

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