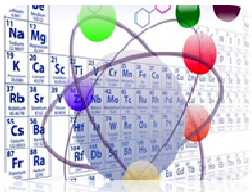
**Indonesian Journal of Chemical Science and Technology (IJCST)**

State University of Medan, https://jurnal.unimed.ac.id/2012/index.php/aromatika

IJCST-UNIMED 2023, Vol. 06, No. 1 Page; 83-88

Received : Jan 7th, 2023 Accepted : Jan 25th, 2023 Web Published : Jan 31st, 2023



# Kinetics Degradation and Shelf Life of Curcumin from Turmeric (*Curcuma domestica* Val) with Ethanol Extract Coated by Maltodextrin at Room Temperature Storage

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**ABSTRACT**

*Curcumin extract from the turmeric plant is unstable to light, temperature and changes in pH, therefore it is necessary to be coated with biopolymers to have a longer shelf life. This study aims to determine the type of degradation kinetics of maltodextrin-coated curcumin and its shelf life at room temperature storage. Encapsulation was performed using an emulsion technique combined with freeze drying with the ratio of turmeric ethanol extract to maltodextrin of 7: 5 (w/w). The results showed that the efficiency of coating ethanol extract of turmeric with maltodextrin was 31.26%. Kinetics degradation of curcumin coated with maltodextrin follows zero-order reaction kinetics. Microcapsule of turmeric ethanol extract coated with maltodextrin has a shelf life at room temperature for 8.35 weeks.*

**Keywords**: turmeric, maltodextrin, kinetics degradation, shelf life, room temperature

## 1. INTRODUCTION

Turmeric (*Curcuma domestica* Val) is a spice and medicinal plant widely spread in Southeast Asia. The chemical content in turmeric extract consists of 30-45% curcuminoids and 15-20% essential oils. Curcumanoids consist of the pigments curcumin, dimethoxy curcumin, and bisdemethoxy curcumin. [1,2] Curcuminoid compounds have many benefits as antioxidants, anti-inflammatory, anti-hepatotoxic, and antirheumatic. [3] Curcumin can be extracted with ethanol solvent which has medium polarity. Ethanol with a concentration of 96% is able to extract curcumin up to 12%. [4]

The unstable behaviors of curcumin can disrupt its health benefits, such as unstable at high temperatures, light, and changes in pH. These deficiencies can be overcome by using coating techniques. The



e-ISSN : 2622-4968, p-ISSN : 2622-1349 

appropriate coating agent used is a biopolymer compound because it has biocompatible properties and is safe for health. Coating or encapsulation methods for natural compounds and medicines have been widely used, such as the encapsulation of active compounds with chitosan,[5] ethylcellulose,[6] and maltodextrin. [7]

Coating of active compounds can be done by several techniques, such as spray drying and freeze drying. Previously, the use of the spray drying method for coating curcumin used maltodextrin and a mixture of maltodextrin, xanthan, and pectin. [8,9] However, the use of the spray drying method uses high temperatures which can affect the stability of curcumin. The advantage of using the freeze-drying technique is that it uses low temperatures, therefore, the active compounds such as curcumin will not degrade. Coating of natural product extracts with maltodextrin using the freeze-drying method has been widely used, such as the coating of dragon fruit extract,[10,11] *Elsholtzia ciliata* extract,[12] tuna fish oil,[13] lycopene,[14] and propolis extract.[15]

Maltodextrin can be used as a curcumin coating because it can stabilize emulsions, easily form matrices, is stable in oil-in-water emulsions, and is non-toxic.[16,17] The use of maltodextrin as a curcumin coating has been carried out in other studies but has never studied the degradation kinetics and shelf life of curcumin at room temperature storage.

## 2. EXPERIMENTAL

### *2.1. Chemicals, Equipment and Instrumentation*

The materials used were turmeric rhizomes that were obtained from the Garden of Kayowa Village, Batui, Central Sulawesi, ethanol 96% (Merck), distilled water, maltodextrin DE 20 (Sigma-Aldrich), curcumin standard (Sigma-Aldrich), and tween 20 (Merck), while the equipment used in this study were a knife, blender, oven, stir bar, analytical balance (Ohaus Corp. Pine Brook), freeze dryer, UV-Vis spectrophotometer (PerkinElmer L850), rotary vacuum evaporator, and sieve 60 mesh.

### *2.2. Research Procedure*

*Extraction of Turmeric*

Turmeric extraction using 96% ethanol. Turmeric rhizomes of 6 kg were cleaned and thinly sliced, then dried in an oven at 50°C for 24 hours. The dry samples were blended and sifted. Turmeric powder was mixed with 96% ethanol solvent with a ratio of 1:10 (w/v), then stirred at 500 rpm for 2 hours at room temperature and allowed to stand for 24 hours. The filtrate is separated and evaporated using a rotary vacuum evaporator. The condensed extract is used at the encapsulation stage.

*Encapsulation of Turmeric Ethanol Extract*

Turmeric ethanol extract of 7 grams was mixed with 5 grams of maltodextrin. The mixture was added 20 mL of distilled water and 5 mL of Tween 20 2%, then stirred at 600 rpm. The mixture was dried using a freeze dryer to obtain encapsulated turmeric ethanol extract. [11,18]

*Determination of Encapsulation Efficiency*

The microcapsules were weighed as much as 0.025 grams and dissolved in 50 mL of 96% ethanol, then 1 mL was diluted in a 10 mL volumetric flask and the absorbance was measured at a maximum wavelength of 422 nm. The curcumin concentration was calculated using the regression equation of the curcumin standard curve. Encapsulation efficiency (EE) is calculated using equation 1. [14]



e-ISSN : 2622-4968, p-ISSN : 2622-1349 

$$EE(\%) = \frac{\left(C_c \times \frac{1}{1000} \times df \times V\right) \times \frac{a}{b}}{m_e} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

where, $C_C$= curcumin concentration (mg/L), df = dilution factor, V= solution volume (mL), a = total mass of encapsulates (g), b = mass of the microcapsules analyzed (g), and $m_e$ = mass of turmeric ethanol extract (mg)

*Determination of Degradation Kinetics and Shelf Life*

The kinetics of curcumin degradation were determined using zero order reaction curves (concentration versus time), first reaction order curves (ln concentration versus time), and second reaction order curves (1/concentration versus time). Curcumin concentrations were determined by using regression equation of standard curcumin every week until the 7th week. The curve that produces a linear line with the highest coefficient of determination ($R^2$) or close to 1 is the chosen kinetic. [5] Shelf life is determined using the reaction order method at room temperature storage. Selected degradation kinetics were used to determine shelf life. Shelf life was calculated at only 30% remaining curcumin concentration using the regression equation $y = ax+b$ of the selected reaction order. The $x$ value is the shelf life of maltodextrin-coated curcumin.

## 3. RESULTS AND DISCUSSION

### *3.1. Encapsulation Efficiency of Turmeric Ethanol Extract with Maltodextrin*

The ethanol extract of turmeric obtained was 111.51 grams with a yield of 22.30%. The ethanol solvent is used because it is able to extract curcumin in turmeric and is non-toxic. The higher the concentration of ethanol used, the more curcumin is extracted. [19]

The encapsulation efficiency of turmeric ethanol extract with maltodextrin on microcapsules was 31.26%. Encapsulation efficiency is affected by the properties of the coating material (viscosity and solubility) and the ratio of core to coating. The right emulsifier concentration in the matrix will produce a high encapsulation efficiency value. [20] The emulsifier used in this study was Tween 20 with a concentration of 2%. This concentration can work effectively to stabilize the emulsion, thereby the coating efficiency is more than 30%. In another study, the encapsulation efficiency of curcumin with yeast was 8%. [21] The EE value of maltodextrin is higher than yeast because the yeast cells have glycoprotein compounds that can react with curcumin, therefore curcumin is not extracted optimally, while maltodextrin does not react with curcumin, thereby curcumin can be extracted properly from microcapsules.

### *3.2. Degradation Kinetics of Curcumin*

Determination of the curcumin concentration of turmeric ethanol extract in encapsulates for each week using the linear equation $y = 0.1517x + 0.0025$ ($R^2 = 0.9987$) that was obtained from the curcumin standard curve (Figure 1). The degradation kinetics are obtained from the reaction order graph. Foodstuffs generally follow zero-order, first-order, or second-order degradation kinetics. The calculation results show that the degradation of curcumin in the maltodextrin matrix follows zero-order kinetics because it has the highest $R^2$ value (0.9845) (Figure 2).



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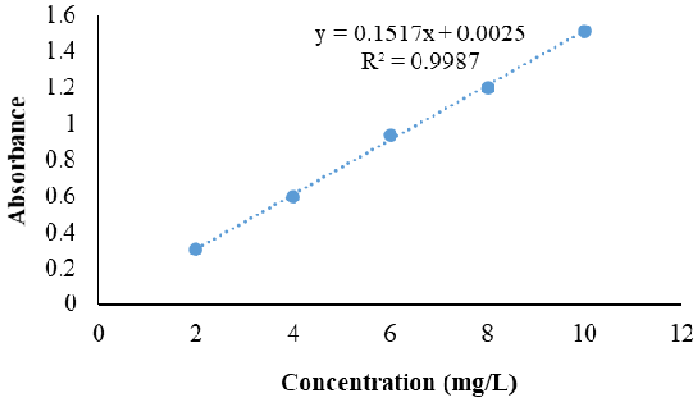


**Figure 1.** Standard curve of curcumin

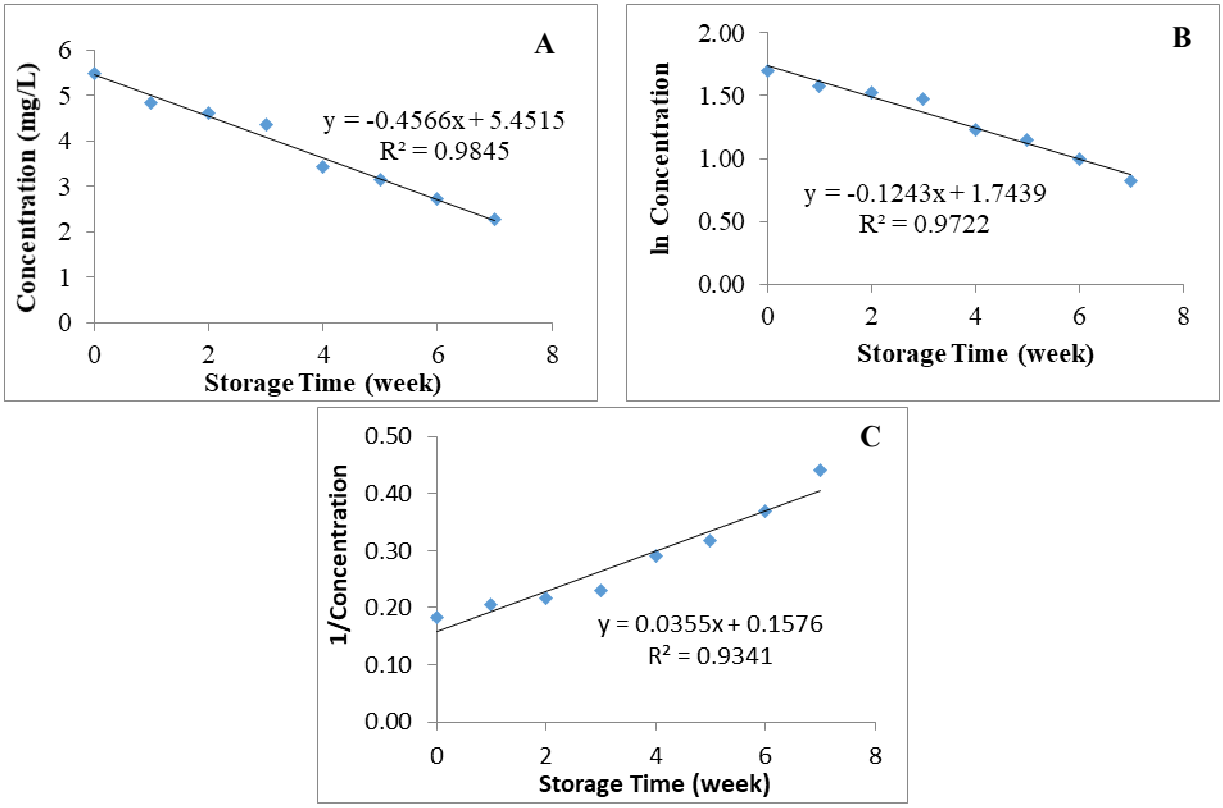


**Figure 2.** Degradation of curcumin at zero-order (A), first-order (B), and (second-order)

The value of $R^2$ in zero-order ($R^2$=0.984) means that 98.4% is influenced by the storage time and the remaining 1.6% is influenced by other factors, such as light, pH, and others (Figure 2a). In another study, the degradation of maltodextrin-coated curcumin pigment in soft drinks and jelly at room temperature also



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followed zero-order kinetics with an $R^2$ value of only 0.669. [22] Storage time generally has a significant effect on the increase in curcumin degradation. [23] Temperature and light can also cause curcumin degradation which follows first-order kinetics. [24] The use of room temperature in this study was intended to determine the durability of maltodextrin-coated curcumin without having to store it at a cooler temperature. Storage at room temperature and dry conditions was also reported to be able to keep curcumin from degrading quickly [23].

### *3.3. Shelf Life of Turmeric Ethanol Extract Coated by Maltodextrin*

The shelf life of maltodextrin-coated turmeric ethanol extract at room temperature was 8.35 weeks which was obtained from the kinetics of curcumin degradation at zero order. Encapsulates are considered to have no use value if the concentration of the active substance is less than 30%. If only 30% of the active substance in food remains, it is considered unfit for use or consumption again. [14]

The shelf life obtained was still shorter than research using a combination chitosan-alginate coating which was able to produce curcumin's shelf life of up to 29.9 weeks at room temperature. [25] This shows that it is necessary to modify the coating to increase shelf life, such as the combination of maltodextrin with other biopolymers.

## 4. CONCLUSION

The encapsulation efficiency of turmeric ethanol extract with maltodextrin was 31.26%. Kinetics of curcumin degradation from maltodextrin-coated turmeric ethanol extract followed zero-order degradation kinetics. The encapsulated shelf life at room temperature reaches 8.35 weeks. In future research, it is necessary to do a combination of maltodextrin and other biopolymers to extend the shelf life of turmeric ethanol extract.

## ACKNOWLEDGEMENT

Acknowledgments are dedicated to Research Laboratory Staff, Chemistry Department, Tadulako University.

## REFERENCES

1. Cano-Higuita, D. M., Vélez, H. A. V. & Telis, V. R. N. (**2015**). Microencapsulation of Turmeric Oleoresin In Binary And Ternary Blends Of Gum Arabic, Maltodextrin And Modified Starch. *Ciênc. agrotec.* 39, 173–182.
2. Honda, S. *et al.* (**2006**). Effects of Ingested Turmeric Oleoresin on Glucose and Lipid Metabolisms in Obese Diabetic Mice: A DNA Microarray Study. *J. Agric. Food Chem.* 54, 9055–9062.
3. Sharifi-Rad, J. *et al.* (**2020**). Turmeric and Its Major Compound Curcumin on Health: Bioactive Effects and Safety Profiles for Food, Pharmaceutical, Biotechnological and Medicinal Applications. *Front Pharmacol* 11, 01021.
4. Popuri, A. K. & Pagala, B. (**2013**). Extraction of Curcumin from Turmeric Roots. *International Journal of Innovative Research and Studies* 2, 289–299.
5. Hardi, J., Sugita, P. & Ambarsari, L. (**2013**). Dissolution Behavior, Stability and Anti-Inflammatory Activity of Ketoprofen Coated Tripolyphosphate Modified Chitosan Nanoparticle. *Indonesian Journal of Chemistry* 13, 149–157.
6. Noviza, D., Harliana, T. & Rasyad, A. A. (**2013**). Mikroenkapsulasi Metformin Hidroklorida Dengan Penyalut Etilsellulosa Menggunakan Metode Penguapan Pelarut. *Jurnal Sains dan Teknologi Farmasi* 8, 75–79.



e-ISSN : 2622-4968, p-ISSN : 2622-1349 

7. Sumanti, D. M., Lanti, I., Hanidah, I.-I., Sukarminah, E. & Giovanni, A. (**2016**). Pengaruh Konsentrasi Susu Skim dan Maltodekstrin Sebagai Penyalut Terhadap Viabilitas dan Karakteristik Mikroenkapsulasi Suspensi Bakteri Lactobacillus plantarum menggunakan metode freeze drying. *JP2* 1, 7–13.
8. Febrianta, H., Yunianto, V. D., Nurwantoro, N. & Bintoro, V. P. (**2022**). Dietary addition of microencapsulated turmeric in an amorphous matrix of maltodextrin on quality characteristics of broiler chicken. *J Adv Vet Anim Res* 9, 221–229.
9. Goëlo, V., Chaumun, M., Gonçalves, A., Estevinho, B. N. & Rocha, F. (**2020**). Polysaccharide-based delivery systems for curcumin and turmeric powder encapsulation using a spray-drying process. *Powder Technology* 370, 137–146.
10. Sucianti, Nurhaeni & Hardi, J. (**2020**). Mikroenkapsulasi Ekstrak Kulit Buah Naga Super Merah (Hylocereus costaricensis) pada Berbagai Massa Maltodekstrin dan Aplikasinya Sebagai Antioksidan: *1* 6, 191–197.
11. Hardi, J., Citra, D., Syamsuddin & Pusptasari, D. J. (**2020**). Efisiensi Mikroenkapsulasi Ekstrak Kulit Buah Naga Super Merah (Hylocereus costaricensis) Tersalut Maltodekstrin Berdasarkan Kecepatan Pengadukan: *KOVALEN: Jurnal Riset Kimia* 6, 1–8.
12. Pudziuvelyte, L. *et al.* (**2020**). Freeze-Drying Technique for Microencapsulation of Elsholtzia ciliata Ethanolic Extract Using Different Coating Materials. *Molecules* 25, 2237.
13. Charles, A. L. *et al.* (**2021**). Characterization of freeze-dried microencapsulation tuna fish oil with arrowroot starch and maltodextrin. *Food Hydrocolloids* 112, 106281.
14. Noviyandari, D., Hardi, J. & Mappiratu, M. (**2019**). Aplikasi Ekstrak Likopen dari Buah Tomat Apel (Lycopersicum pyriforme) Tersalut Maltodekstrin Pada Pengolahan Mie Instan Fungsional. *KOVALEN: Jurnal Riset Kimia* 5, 322–329.
15. Mangiring, G. A. *et al.* (**2018**). Microencapsulation of ethanol extract propolis by maltodextrin and freeze-dried preparation. in AIP Publishing, 1933 1–6.
16. Zungur, A., Koç, M. & Ertekin, F. K. (**2015**). Physical Properties of Olive Oil in Water Model Emulsion: Effect of Aqueous and Oil Phase Concentration and Homogenization Types. *Akademik Gıda* 13, 22–34.
17. Udomrati, S., Ikeda, S. & Gohtani, S. (**2011**). The effect of tapioca maltodextrins on the stability of oil-in-water emulsions. *Starch - Stärke* 63, 347–353.
18. Herdini, Darusman, L. K. & Sugita, P. (**2010**). Disolusi Mikroenkapsulasi Kurkumin Tersalut Gel Kitosan-Alginat-Glutraldehida. *Makara, Sains* 4, 57–62.
19. Oktavianingsih, W., Hariyani, N. & Hartati, F. K. (**2018**). Evaluasi Residu Etanol Pada Maserat Curcumin Rimpang Kunyit (Curcuma longa Linn.). *Jurnal Teknologi Proses dan Inovasi Industri* 3, 27–31.
20. Mirzajani, F., Rafati, H. & Atyabi, F. (**2010**). Fabrication of biodegradable poly(d,llactide- co-glycolide) nanoparticles containing tamoxifen citrate. *Iranian Polymer Journal* 19, 437–446.
21. Sentosa, O., Katherine, Sugih, A. K. & Unpar, S. N. T. K. (**2015**). Pengaruh suhu dan konsentrasi yeast dalam enkapsulasi kurkumin dengan yeast saccharomyces cerevisiae. in *Prosiding Seminar Nasional Teknik Kimia UNPAR* 281, UNPAR, Bandung.
22. Tensiska, T., Nurhadi, B. & Isfron, A. F. (**2012**). Kestabilan Warna Kurkumin Terenkapsulasi dari Kunyit (Curcuma domestica Val.) dalam Minuman Ringan dan Jelly pada Berbagai Kondisi Penyimpanan. *Bionatura: Jurnal Ilmu-ilmu Hayati dan Fisik* 14, 198–206.
23. Green, C. E. *et al.* (**2008**). Extraction, Processing, and Storage Effects on Curcuminoids and Oleoresin Yields from Curcuma longa L. Grown in Jamaica. *J. Agric. Food Chem.* 56, 3664–3670.
24. Kumavat, S. D. *et al.* (**2013**). DEGRADATION STUDIES OF CURCUMIN. *International Journal of Pharmacy Review & Research* 3, 50–55.
25. Herdini. (**2008**). Mikroenkapsulasi Ekstrak Rimpang Temulawak (Curcuma xanthorriza Roxb) Tersalut Gel Kitosan Alginat. *Tesis.* Institut Pertanian Bogor, Bogor.




e-ISSN : 2622-4968, p-ISSN : 2622-1349 