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Microencapsulation of natural antioxidant powder from *Aloe vera* (L.) skin using Foam mat drying method

[1,3*]Narsih, [2]Sri Kumalaingsih, S., [2]Usinggih, W. and [2]Wignyanto

[1]Department Agricultural Technology, Pontianak State Polytechnic, Jalan Ahmad Yani, Pontianak, Kalimantan Barat, Indonesia 78124
[2]Department Agroindustrial Technology, Faculty of Agricultural Technology, Brawijaya University, Jalan Veteran Malang, Jawa Timur, Indonesia 65145
[3]Doctoral Program of Agricultural Sciences, Brawijaya University, Jalan Veterang Malang, East Java of Indonesia 65145

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Abstract

Microencapsulation of natural antioxidant powder from *Aloe vera* (L.) skin using 10% maltodextrin, 0.3% tween 80 and drying at 600C produced free radical scavenging activity using DPPH (88.31%), total phenol (34.921%), and α tocopherol by HPLC (87.789mg/g). The results of GC-MS analysis as phyto-component were squalene (16.84%), 7 tetradecane (13.13%), limonene (14.17%), n-Hexadecanoic acid (11.91%) and α-Tocopherol (4.18%). And the results of FTIR analysis were phenol, aromatic, substituted alkenes, aromatic acid halide, aliphatic acid halide, eter R-O-R, Nitro NO_2, Keton R-CO-R,vinilidene, carboxylic acid, metilene and OH. And the results of SEM analysis showed that drying product by foam mat method has a structure which is easier to absorb water and can dissolved in cold water. The result of this study indicated that microencapsulation on aloe vera skin powder improved the bioactive properties as contained phyto-component as antioxidant agent

Introduction

Aloe vera (L.) is a tropical or subtropical plant which use in medicine folk, cosmetic, supplement and food material (Eshun and He, 2004). Recently, the part of *Aloe vera* (L.) is seldom used as food processing, however, Miladi and Damak (2008) noted that *Aloe vera* (L.) skin contained pharmaceutical compound such as antioxidant, therefore it very possible to be processed into natural antioxidant powder.

The processing of *Aloe vera* (L.) skin becomes natural antioxidant powder need encapsulation such as maltodextrin, tween 80 as foaming agent, and low drying temperature (60^0C). Finotelli and Rocha-Leão suggested that the addition of maltodextrin as encapsulation can protect the release of nutrient component, protected the important compound such as antioxidant from extreme temperature, whilst Iswari (2007) noted that tween 80 as foaming agent and to help figuration of good suspension. And also Thaisong and Rojanakorn (2011) suggested that drying temperature between 60-75^0C was the best temperature in maintaining the quality of powder.

Rajkumar *et al*. (2007) noted that the drying with the addition of foaming agent will produce a good quality of product. This is in agreement to the findings by Kudra and Ratti (2008) who reported that the drying process by using foaming material will decrease the drying time. However, the objectives of current research were to find out the effect of microencapsulation from natural antioxidant powder of *Aloe vera* (L.) skin using maltodextrin, tween 80 and drying at 60^0C to the antioxidant compounds.

Materials and Methods

Sample preparation

Aloe vera (L.) skin of 10 months old were obtained from Kalimantan Barat, Indonesia. After harvesting the *Aloe vera* (L.) skin were separated from the gel, then washed by aquades. *Aloe vera* (L.) skin was extracted at 80^0C for 60 minutes. The filtrates obtained were then added by 10% maltodextrin, 0.3% tween 80 and homogenizing using mixer at a speed of 1800 rpm for 10 minutes. The obtained rough were scattered on the baking pan with alumunium foil and dried at 60^0C for 6 h. The already dried rough was blended and sifted using sieve 100 mesh.

Determination of antioxidant activity

The *Aloe vera* (L.) skin powder were analyzed for

*Corresponding author.
Email: *narsih78@gmail.com*

its antioxidant activity using DPPH (2,2-diphenyl-2-picrylhydrazyl) radical scavenging assay. Sample (200 g) was dissolved in 100 mM Tris–HCl buffer (800 µl, pH 7.4) and then added 1 ml 500 µM DPPH. The solutution was shaked until homogenized and storage in dark room for 20 minute. Spectrophotometry was used to determine the absorbance at 517 nm.

Determination of α-tocopherol

The *Aloe vera* (L.) skin powder were analyzed for α-tocopherol content using HPLC (High Performance Liquid Cromatography) under the following condition : column used were inertsil NH_2 µm250 x 4.6 mm, and the flow rate was 1 ml/ minute. The column temperature was 30^0C, detector UV 290nm and using ethyl acetate/n hexane 30/70 as gas carrier.

Determination of phytocomponent

The *Aloe vera* (L.) skin powder were analyzed for phytocomponent using GC-MS QP2010S-Shimadzu under the following condition : column used were Rtx-5MS, 30 m length and inner diameter of 0.25 mm and the initial column temperature was 40^oC and final temperature was 260^oC (5o C/minute), while the injector temperature was 250^oC with split mode injector and split ratio of 68 and pressure of 14.0 kPa. The flow rate was 1.3 ml/minute and the flow within the column was 0.50 ml/minute. The detector temperature was 300^0C and using Helium as the gas carrier with EI (Electron Impact); and the samples volume injected was 1µl. Compounds were identified by comparing retention indices/comparing mass spectra of each compound with those of authentic samples and library.

Determination of functional compounds

The *Aloe vera* (L.) skin powder were analyzed for its functional compounds using FTIR (Fourier Transform Infra Red). The IR spectra were recorded on FTIR-8400S (Shimadzu Deutchland GmbH) spectrophotometer in KBr and polyethylene pellets. Samples were weigh-in at 0.01 g and homogenized with 0.01 g KBr anhydrous by mortar agate. The mixture of sample and KBr were pressed by vacuum hydrolic (Graseby Specac) at 1.2 psi to obtained transparency pellet. Scanned sample passed through infra red, where its continuing wave by detector that connected to computer and given described of tested sample spectrum. Samples were usually scanned in the absorption area of 500-4000 cm^{-1}. The results of analysis consisted of chemical structure, molecular binding form and certain functional group of tested sample as basic of spectrum type.

SEM studies

The microstructure of *Aloe vera* (L.) skin powder were analyzed using SEM (Scanning Electron Microscopy) JSM T-100, JEOL, Japan. Samples were dehydrated by putting it's into critical point drying equipment, then fastened with a special glue to stub (samples holder). Samples were let them dried for ± 1 day. Samples were coated with pure gold or carbon for 1 h at a coating evaporator machine prior to be observed and taken its microscopic photos by scanning electron microscope (SEM) machine.

Results and Discussion

Free radical scavenging activity

The antioxidant activity of *Aloe vera* (L.) skin powder determined using DPPH assay (%) was 88.31% and this result is higher than synthetic antioxidant such as BHT (butylated hydroxytoluene) i.e 70.5% and α-tocopherol i.e 65.65 as reported by Anilakumar *et al*. (2010). An increase of free radical scavenging activity was found in *Aloe vera* (L.) skin powder. This increase in antioxidant activity probably appeared to be relatively resistant to the effect of drying temperature, in addition the effect of encapsulation, maltodextrin and tween 80. Therefore, Patras *et al*. (2009) suggested that the increase in free radical antioxidant could be due to better extractability of antioxidant component and also occured the increasing of phenolic content. An observation was reported by Pengseng *et al*. (2010), who reported that phytochemicals such as phenolic content, ascorbic acid, tocopherol and pigment also contribute to total antioxidant activity and has a good correlation between the antioxidant activity and its total phenolic compound content.

Total phenol content

Total phenol content of *Aloe vera* (L.) skin powder was 34.921%. Saénz *et al*. (2009); Desai and Park (2005) noted that maltodextrin can improve the stability of phenol compound as maltodextrin can protect phenol compound from oxidation effect, oxygen, water and extreme temperature. While Pengseng *et al*. (2010) noted that the use temperature between 25-90^0C were undamaged antioxidant component in material, therefore, total phenol in this research still within the limits of safe in protected bioactive compound.

α-tocopherol content

α-tocopherol content obtained from *Aloe vera* (L.) skin powder was 87.789 mg/ 100g and its typical chromatogram is shown on Figure 1.

α-tocopherol content on *Aloe vera* (L.) skin powder obtained were influenced by drying methods,

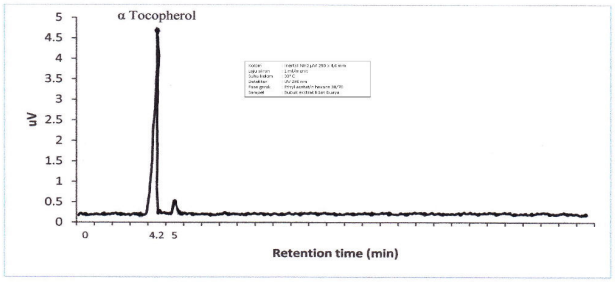

Figure 1. HPLC chromatogram of *Aloe vera* (L.) skin powder α-tocopherol

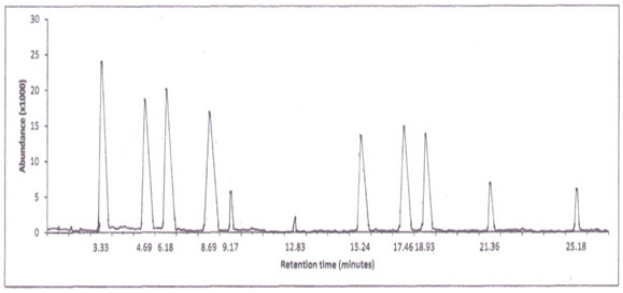

Figure 2. GC-MS chromatogram of *Aloe vera* (L.) skin powder

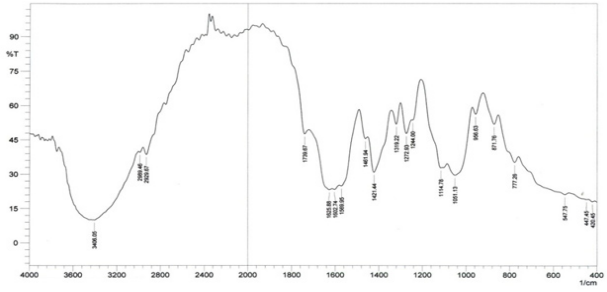

Figure 3. Infra red spectrum of *Aloe vera* (L.) skin powder

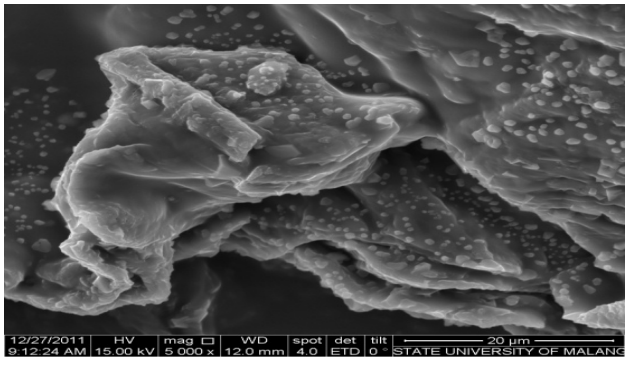

Figure 4. Microstructure of *Aloe vera* (L.) skin powder

in addition in addition the effect of encapsulation, maltodextrin and tween 80. Estiasih and Sofia (2009) suggested that drying using foaming method lead surface area becomes higher, therefore contact of product becomes higher which allows the oxidation process easier occurred and affects on tocopherol. This is due to tocopherol has unstability condition to environment factors. Saguy *et al*. (2003) noted that the heated effect lead α-tocopherol becomes unstable as a several reaction will occurred such as hydrolysis, oxidation and polymerization during direct contact with heat. Therefore, Lešková *et al*. (2006) suggested that its negative alteration will lead decrease of α-tocopherol as antioxidant agent.

Identification antioxidant compounds of Aloe vera (L.) skin

A typical gas chromatogram of *Aloe vera* (L.) skin powder is shown on Figure 2 and a list of the compounds identified appears on Table 1. Eleven compounds of *Aloe vera* (L.) skin powder were identified using GC-MS and the major compound identified was squalene (16.84%), limonene (14.17%), 7- tetradeecane (13.13%) and n-Hexadecanoic acid (11.91%). Lakshmi *et al*. (2011) reported that the major phyto-components to have the activity as antimicrobial and antioxidant were tetradecanoic acid, methyl ester, hexadecanoic acid, and squalene. Whilst Botes *et al*. (2008) reported that campesterol and coumaric were identified as phytosterols in *Aloe greatheadii* var. *davyana* extracts and associated antioxidant properties and Coopoosamy (2010) also reported that limonene and carvone were was performed as volatile compounds on leaf exudates of *Aloe excelsa* (Berger).

Identification antioxidant compounds by FTIR

The infra red spectrum of *Aloe vera* (L.) skin powder as shown in Figure 3 was in the wave length range of 420.45 to 3406.05 cm^{-1}, and there was 20 functional compounds found (Table 5). According to Table 2 and Figure 3, the presence of broad bands at 3406.05 cm^{-1} can be attributed to (OH) stretching vibrations. The wave length at 2989.46 to 2929.67 cm^{-1} ; 1319.22 to 1569.95 cm^{-1}; and 1051.13 to 1272.93 cm^{-1} can be attributed to metilene group, aromatic group and eter (R-O-R), respectively. Rajendran *et al*. (2007) reported that the functional compounds of *Aloe vera* (L.) were presence the wave length at 611.4 cm^{-1}; 717.5 cm^{-1}; 1051.1 cm^{-1}; 1398.3 cm^{-1}; 1623.9 cm^{-1}; 1730.0 cm^{-1}; 2912.3 cm^{-1}; 3155.3 cm^{-1} dan 3398.3 cm^{-1}.

SEM study

Scanning electron micoroscopy (SEM) conducted at magnification 5000x. As shown on Figure 4, microstructure of *Aloe vera* (L.) skin powder contained bubbles or spotted on the surface due to the use of tween 80 as foaming agent. Kudra and Ratti (2006) noted that the drying process combined with foaming agent will lead cavity on material surfaces, therefore water will accelerated move out than drying process without foaming agent. It suggested that

Table 1. Identified compounds of *Aloe vera* (L.) skin powder

Peak	Compounds	%RA
1	Squalene	16.84
2	7-Tetradecane	13.13
3	Limonene	14.17
4	n-Hexadecanoic acid	11.91
5	Campesterol	3.96
6	B-Sitosterol	1.43
7	9-octadecanoic methyl ester	9.53
8	Carvone	10.43
9	Comaric	9.58
10	Lupeol	4.80
11	α-Tocopherol	4.18

Table 2. Functional compounds of *Aloe vera* (L.) skin powder analyzed by using FTIR

No	Wave length (cm^{-1})	Vibration type	Functional compound
1	420.45	C-OH bend	Phenol AR-H
2	447.45	OH bend	Phenol AR-H
3	547.75	Def cincin 2p	Aromatic
4	777.26	CH_2 kel.ben.wag	Alkena substituted
5	871.76	C-C or C-Cl stretch	Aromatic acid halide
6	956.63	C-Cl stretch	Aliphatic acid halida
7	1051.13	C-O-C stretch eter siklis	Eter ROR
8	1114.78	C-O-C stretch eter siklis	Eter ROR
9	1244	C-O-C stretch vinil eter	Eter ROR
10	1272.93	C-O-C stretch alkil aril eter	Eter ROR
11	1319.22	NO_2 stretch aromatic	Nitro NO_2
12	1421.44	Ring aromatic stretch (4p)	Aromatic
13	1461.94	NO_2 stretch aromatic	Nitro NO_2
14	1569.95	NO_2 stretch aromatic	Nitro NO_2
15	1602.74	C=C stretch konj	Keton RCOR
16	1625.74	C=C stretch	Vinilidena
17	1739.67	C=O stretch monomer	Carboxylic acid
18	2929.67	CH stretch into alkena	Metilena CH_2
19	2989.46	CH stretch into alkena	Metilena CH_2
20	3406.05	OH stretch bonded	OH

the the density of powder produced is lower that of non-foamed ones as a lot of bubbles contained on dry product. This is in agreement to the findings by Iswari (2007) who reported that drying product by foam mat method has a structure which is easier to absorb water, therefore food can dissolved in cold water.

Conclusion

Microencapsulation of natural antioxidant powder from *Aloe vera* (L.) skin using 10% maltodextrin, 0.3% tween 80 and drying at 60^0C produced free radical scavenging activity using DPPH (88.31%), total phenol (34.921%), and α tocopherol by HPLC (87.789mg/g).The increase in free radical antioxidant could be due to better extractability of antioxidant component and also occured the increasing of phenolic content. The results of GC-MS and FTIR analysis contained phyto-component as antioxidant agent. And the results of SEM analysis showed drying product by foam mat method has a structure which is easier to absorb water and can dissolved in cold water.

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