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Characteristics of microcapsules of *Protium javanicum* leaf extract using maltodextrin and gelatin as encapsulant

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Abstract
This study aims to determine the ratio of maltodextrin and gelatin as encapsulant to produce *Protium javanicum* leaf extract microcapsules with the best properties. The study started with the extraction of *Protium javanicum* leaves by maceration method using 90% ethanol, followed by microencapsulation by lyophilization method using maltodextrin (M) and gelatin (G). There are 5 combinations of the maltodextrin to gelatine ratio, namely MG1 (1: 1), MG2 (1: 1.25), MG3 (1: 1.5), MG4 (1: 1.75) and MG5 (1: 2). Observations were made on the chemical composition of the extracts, physical and chemical characteristics of the microcapsules including: moisture content, yield, particle morphology, total phenolic content, antioxidant activity and encapsulation efficiency. The analysis showed that the ethanolic extract of *Protium javanicum* leaf had a yield of 21.9 ± 0.65 %, total phenolic content of 243.81 ± 0.70 mg GAE/g and IC50 of 20.60 ± 0.46 ppm. The ratio of maltodextrin to gelatin had a significant effect on microcapsule moisture content, yield, total phenolic content, surface phenolic content, antioxidant activity and encapsulation efficiency. Observation of particle morphology by scanning electron microscopy (SEM) showed that the microcapsule particles were irregularly shaped like glass flakes. Microcapsules with the best characteristics were obtained from the ratio of maltodextrin and gelatin of 1:1 with the criteria of yield 76.14 ± 0.12 %, moisture content 2.84 ± 0.04 %, total phenolic content 119.77 ± 0.78 mg GAE/g, surface phenolic content 2.18 ± 0.24 mg GAE/g, antioxidant activity 86.10 ± 0.26 %, encapsulation efficiency 98.17 ± 0.21 %, irregular shaped particle, smooth and few voids.

Keywords: *Protium javanicum*, encapsulant, microcapsules, maltodextrin, gelatin

Introduction

Protium javanicum is a plant of the Protium genus that is used for traditional medicine. In Bali, Indonesia, *Protium javanicum* has the local name *Tenggulun*. The leaves of *Tenggulun* are usually used as vegetables or complementary spices, processed into herbal medicine to treat digestive disorders such as diarrhea, abdominal pain and cough. Previous research reported that *Protium javanicum* leaves contain phenolic compounds such as quersetin, scopoletin [1], flavonoids, tannins, steroids, and terpenoids [28]. Simamora *et al*. [29] showed that the methanolic extract of *Protium javanicum* leaves contained total phenolic of 38.56 mg GAE/g, and antioxidant activity based on IC_{50} value of 13.52 ppm.

The phenolic compounds in *Protium javanicum* leaf extract has the potential to be developed as an agent for the prevention and treatment of diseases. Several studies on the biological activity of *Protium javanicum* have been conducted including the ability to significantly reduce malondialdehyde (MDA) levels. and increase SOD activity in rats exposed to cigarette smoke [25], anti-inflammatory activity [28], as an immunostimulant [12] and potentially as an anticancer [24].

One of the constraints of the extract characteristics of phenolic compounds is that they are highly susceptible to degradation due to storage conditions (such as temperature, oxygen and light). Oral administration of phenolic compounds has limitations in terms of permeability, absorption and is unstable in the digestive tract which leads to reduced bioavailability [6] [13]. Therefore, protection is needed to maintain its physical, chemical and biological characteristics and allow controlled release of particles at the right time, rate, dose and place, namely by microencapsulation.

Microencapsulation is the technology of encapsulating liquids, solids, and gases in capsules in a microform where the capsules can release their contents under certain conditions [15]. A commonly used method for microencapsulation of bioactive compounds is lyophilization. Freeze drying is the most suitable microencapsulation method for heat labile substances such as phenolic compounds.

The selection of an appropriate coating material is very important in the microencapsulation process. The ideal coating material should be compatible with the core material, have film-forming and emulsifying properties, be biodegradable, resistant to the gastrointestinal tract, have low viscosity, high solids content, and be inexpensive [27]. When using a single coating material, it is sometimes not possible to obtain microcapsules with the expected criteria. Good microcapsule characteristics are indicated by high retention of core material and minimal amount of core material on the surface of powder particles, as well as the absence of cracks on the microcapsule surface, which indicates non permeability of the wall and thus avoids loss of the core [20].

Maltodextrin and gelatin are a suitable combination of coating material for the microencapsulation of phenolic compounds by lyophilization [10]. Maltodextrin has high solubility, low viscosity and forms a colorless solution. The disadvantage of maltodextrin is that it has poor emulsifying properties, so it is necessary to combine maltodextrin with other encapsulant.

Gelatin is a coating material with good emulsifying and film-forming properties, water solubility, and the ability to

form finer solid complexes. Each coating material has its own advantages and disadvantages, so it is necessary to find the right comparison of coating materials to achieve higher encapsulation efficiency and lower cost. Zhao *et al*. [37] reported that a ratio of 3:7 between gelatin and maltodextrin produced microcapsules of *Cornus offcinalis* extract with a higher encapsulation efficiency (93.26%) than the ratios of 2:3 and 1:3. Microencapsulation technology has been proven to be one of the methods that can increase the bioavailability of phytochemical compounds [21]. The aim of this study was to determine the proper ratio of maltodextrin and gelatin to produce microcapsules of ethanolic extract of *Protium javanicum* leaves with the best properties.

Materials and Methods

Materials and instrumentations

The main materials used in this research are *Protium javanicum* leaves, maltodextrin (DE 12) and gelatin. The *Protium javanicum* leaves used were mature leaves collected from the Bukit Jimbaran area. The chemicals used include: distilled water, 90% ethanol, acetic acid glacial (p.a), DPPH (2,2-diphenyl-1-picrylhydrazy) (Himedia), gallic acid standard (Sigma-Aldrich), Folin-ciocalteu (Merck), Na_2CO_3 (Merck), and methanol,

The main instrumentations used in this research are rotary vacuum evaporator (IKA RV 10 Basic), SEM (JSM-IT200), freeze dryer (DW-10N Freeze Dryer), analytical balance (Shimadzu ATY224), oven, mixer (Cosmos), centrifuge (Danamon IEC), vortex (Maxi Mix II type 367000, Whatman No. 1 filter paper, aluminum foil (Klin Pack), spectrophotometer (Genesys 10S UV-Vis), micropipette (Socorex), and glassware.

Extraction of *Protium javanicum* leaves

The extraction of *Protium javanicum* leaves by maceration method according to Simamora *et al.* [29] with slight modifications. *Protium javanicum* leaves were sorted and cleaned and then dried using a dehydrator at 50ºC for 5 hours. The dried leaves were ground and sieved (60 mesh) to obtain a fine powder. A total of 10 g of powder was macerated with 100 ml of 90% ethanol for 24 hours at room temperature. The solution was filtered with Whatman No. 1 filter paper and the filtrate was concentrated using a rotary vacuum evaporator at 40ºC, 200 mBar, 60 rpm speed.

Microencapsulation of *Protium javanicum* extract

Microencapsulation was performed by freeze drying method according to Pudziuvelyte *et al* [22] with modifications. Maltodextrin (M) and gelatin (G) were prepared according to the ratio namely MG1 (1: 1), MG2 (1: 1.25), MG3 (1: 1.5), MG4 (1: 1.75) and MG5 (1: 2). The total amount of coating material used was 10% of the solution volume. Gelatin was dissolved in warm water and stirred at 300 rpm, while maltodextrin was dissolved in distilled water and stirred until a homogeneous solution was obtained. Five percent of extract was mixed with the coating material, then homogenized with a stirrer at 750 rpm for 30 minutes and a homogenizer at 18000 rpm for 6 minutes. Sampel was then lyophilized at -54.8ºC, 4,4 Pa for 72 hours.

Analysis of *Protium javanicum* extract

Total phenolic content: The total phenolic content of the extract was determined by the Folin–Ciocalteu method according to Baba and Malik [4] with modification. A total of 50µL of crude extract (1 mg/mL) was added to 150 mL of methanol and 3 mL of distilled water, mixed thoroughly with 0.5 mL of Folin–Ciocalteu reagent for 3 min, followed by the addition of 2 mL of 20% (w/v) sodium carbonate. The mixture was allowed to stand for a further 60 min in the dark, and absorbance was measured at 650 nm. The total phenolic content was calculated from the calibration curve, and the results were expressed as mg of gallic acid equivalent per g dry weight.

Antioxidant activity: The antioxidant activity of the extract was determined by the 1,1-diphenyl-2-picryl-hydrazyl (DPPH) assay, as described earlier with some modifications [34]. Briefly, a total of 1 mg of extract was dissolved with methanol to a volume of 5 mL and vortexed to homogeneity. A variation of the sample concentration was made, methanol was added to a volume of 500 µL, and 500 µL of DPPH solution was added. The mixture was incubated at 25ºC for 30 minutes and the absorbance was measured using UV-Vis spectrophotometry at a wavelength of 517 nm. The ability of the sample to scavenge DPPH radical was calculated as follow:

$$\%\ Inhibition = \frac{OD\ Control - OD\ Sampel}{OD\ Control} x\ 100\%$$

The IC_{50} value was determined by calculating the regression analysis of % inhibition against the concentration of crude extract.

Analysis of microcapsules

Encapsulation Efficiency (EE): The determination of encapsulation efficiency according to Cilek *et al*. [7]. Encapsulation efficiency is the ratio of total encapsulated phenolic content to total phenolic compound content (TPC). Encapsulated phenolic content was determined based on the difference between total phenolic content (TPC) and surface phenolic content (SPC).

Total phenolic content (TPC): 100 mg of microcapsules were dissolved in 1 ml of ethanol: acetic acid: water mixture (50: 8: 42) and vortexed for 1 minute. The solution was filtered through Whatman No. 1 filter paper.

Surface phenolic content (SPC): A total of 100 mg of microcapsules were mixed with 1 mL of ethanol: methanol (1:1) mixture. The mixture was vortexed for 1 min at room temperature and filtered with filter paper. Total and surface phenolic content was quantified as in the previous method. Encapsulation efficiency was determined using the following equation:

$$EE\ (\%) = \frac{TPC - SPC}{TPC} x\ 100\%$$

Morphological analysis of microcapsules: The morphological characteristics of the freeze-dried powders were examined using Scanning Electron Microscopy (SEM) (JSM-IT200).

Yield of microcapsule (Y): Yield of microcapsule was determined by comparing the total mass of microcapsules obtained after encapsulation and the total mass of solids before encapsulation.

$$Y\ (\%) = \frac{M2}{M1} x\ 100\ \%$$

M1 = Mass of solid feed
M2 = Mass of powder collected

Water content (WC): Analysis of water content of the samples was carried out using the thermos-gravimetric method [3]. A total of ± 2 g of microcapsules were placed in an aluminium beaker of known weight and dried in an oven at 100 - 105ºC for 4 hours. The sample was cooled in a desiccator for ± 15 minutes and weighed. This treatment was repeated until a constant weight was obtained. The moisture content of the sample can be calculated using the following formula:

$$WC\ (\%) = \frac{F1\ (g) - F2\ (g)}{F1}\ x\ 100\%$$

F1 = Fresh sampel weight
F2 = Dry sample weight

Antioxidant activity: The antioxidant activity of microcapsules was determined by the 1,1-diphenyl-2-picryl-hydrazyl (DPPH) assay, refers to Villano *et al*. [34]. Briefly, 100 mg of microcapsules were dissolved in 1 ml of ethanol: acetic acid: water mixture (50: 8: 42) and vortexed for 1 minute. The solution was filtered through Whatman No. 1 filter paper. Antioxidant activity was quantified as in the previous method.

Statistic analysis
The experimental design used in this study was Completely Randomized Design. All experiments were performed in triplicate. Results were expressed as mean ± standard error. Differences in mean values were tested using a one-way Analysis of Variance (ANOVA) and continued with the Duncan Multiple Range Test (DMRT) using the Statistical Program for Social Science (SPSS) software version 24.

Results and discussion

Characteristics of *Protium javanicum* leaf extract.

The chemical characteristics of *Protium javanicum* leaf extract are presented in Tables 1. Based on the data in Table 1, *Protium javanicum* leaf extract has a yield of 21.90%, contains 243.81 mg GAE/g of phenolic compounds and an IC_{50} value of 20.60 ppm.

Table 1: Chemical properties of *Protium javanicum* leaf extract

Parameter	Level
Yield (%)	21.9 ± 0.65
Total phenolic (mg GAE/g)	243.81 ± 0.70
Antioxidan activity (IC_{50}) (ppm)	20.60 ± 0.46

Previous research by Simamora *et al*. [29] reported that etanolic *Protium javanicum* leaf extract gave a yield of 14.99% (lower than the results of this study). *Protium javanicum* leaf extract has the potential to be developed as an antioxidant because it contains phenolic compounds with strong antioxidant activity. Adfa *et al*. [1] reported that the flavonoid group in *Protium javanicum* extract included quarsetin and scopolectin. The levels of total phenolic compounds, in this study were also higher than previously reported. Various factors can affect the properties of extracts, including differences in solvent type, solvent polarity, extraction time, and extraction method used [36].

Characteristics of microcapsules

Encapsulation Efficiency (EE).

The ability of the wall materials to encapsulate or retain the core material inside the microcapsule is known as the encapsulation efficiency, which is a crucial indicator for microencapsulated particles. Table 2 shows that the ratio of maltodextrin and gelatin had a significant effect on the encapsulation efficiency of microcapsules. MG1 microcapsules showed the highest EE value of 98.17%, while MG5 had the lowest EE value of 93.45%.

Table 2: Total phenolic content, surface phenolic content and encapsulation efficiency of microcapsules of *Protium javanicu*m leaf extract based on the ratio of maltodextrin to gelatin.

Sampel (M: G)	Total Phenolic Content (mg GAE/g)	Surface Phenolic Content (mg GAE/g)	Encapsulation Efficiency (%)
MG1 (1: 1)	119.77 ± 0.78^{e}	2.18 ± 0.24^{a}	98.17 ± 0.21^{e}
MG2 (1: 1.25)	117.58 ± 0.31^{d}	2.62 ± 0.51^{b}	97.76 ± 0.03^{d}
MG3 (1: 1.5)	112.41 ± 0.32^{c}	5.78 ± 0.12^{c}	94.85 ± 0.11^{c}
MG4 (1: 1.75)	105.68 ± 0.93^{b}	6.16 ± 0.20^{d}	94.16 ± 0.21^{b}
MG5 (1: 2)	104.10 ± 0.48^{a}	6.81 ± 0.08^{e}	93.45 ± 0.07^{a}

Description
M = Maltodextrin, G = Gelatin
Data shown as the mean value of 3 replicates ± standard deviation.
Different lowercase superscripts show a significant effect ($P<0.05$)

Based on the analysis of total phenolic content and surface phenolic content, MG1 microcapsules has the lowest surface phenolic content (2.18 mg GAE/g), so the encapsulation efficiency value is the highest. MG5 microcapsules with the highest surface phenolic content (6.81 mg GAE/g) had the lowest encapsulation efficiency.
Achieving excellent retention of the core materials and minimal amounts of the core materials on the powder particle surface are necessary for a successful encapsulation process [20]. Table 2 shows that the use of a higher amount of gelatin results in a lower value of the encapsulation efficiency. Jafari *et al*. [11] state that the factors that can affect the efficiency of encapsulation are the properties of the wall and core materials, as well as the emulsion characteristics and drying parameters. Gelatin has good properties as a coating material because it has good emulsifying properties, can form a film, is soluble in water, has high stabilizing activity, and tends to form a dense network. However, in this study, the higher the ratio of maltodextrin to gelatin, the rougher the surface morphology of the microcapsules and the more voids, allowing more nuclei to diffuse out, thus reducing the encapsulation efficiency.
The high encapsulation efficiency also indicates the high level of phenolic compounds that can be encapsulated in the

microencapsulation process. As measured by the total phenolic content of the microcapsules, the use of higher levels of gelatin does not appear to maximize the incorporation and retention of the functional compounds within the encapsulation matrix. This is probably because gelatin has the ability to form a gel, so at higher concentrations it tends to produce a viscous feed solution and makes the homogenization process more difficult, thus the encapsulation becomes imperfect and can reduce the total phenolic content in the microcapsules.

Surface morphology of microcapsules

Figure 1 shows the scanning electron micrographs of microcapsule by freeze-drying.

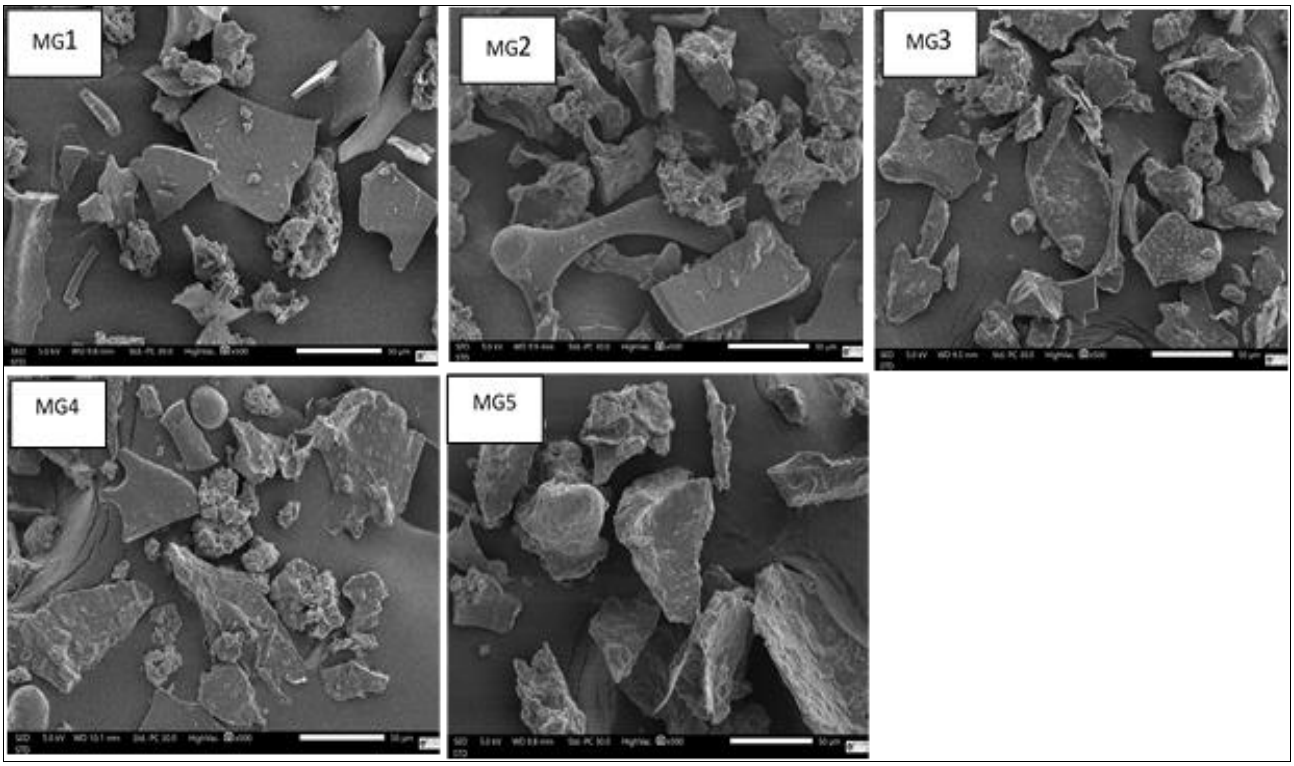

Fig 1: Scanning electron micrographs of microcapsule of *Protium javanicum* leaf extract, (500X magnification)

The Scanning Electron Microscopy (SEM) is the most convenient visual technique to prove the surface morphology of particles. Scanning electron micrograph shows that all samples have irregular shapes resembling glass flakes. MG1 microcapsules has the smoothest surface with few rough and hollow parts compared to the other samples. As the ratio of maltodextrin to gelatin increased, microcapsules with a rougher and hollow surface structure were produced. Sample MG5 had the roughest and most hollow surface structure.

Many studies have reported a similar morphology for freeze dried microcapsules [2] [33] [22]. These particles came in a variety of sizes and featured asymmetrical shapes and scales. Because there was little water in the liquid state and sublimation, the freeze-dried samples were porous and wrinkle-free. These particles scaly shape resulted from treating them at extremely low temperatures and vacuum pressure, which imposed pressure on the particles [2]

Pang *et al*. [23] reported that the microstructure of 2.5% gelatin gel at pH 6.6 formed a denser structure with voids compared to the microstructure of 1% gelatin gel. On the other hand, Takeiti *et al*. [32] reported that the microstructure of maltodextrin consisted of a mixture of spherical, cylindrical and filamentous particles with a smooth surface structure. Ezhilarasi *et al*. [9] also reported that encapsulation with maltodextrin showed a sticky structure, particle aggregation and loss of porous structure. Thus, the results of this study are consistent with those reported by several researchers. Mahdavi *et al*. [20] reported that a good microcapsule surface is indicated by the absence of cracks/cavities on the microcapsule surface, which indicates wall non permeability and thus avoids loss of nuclei. Based on these criteria, MG1 microcapsules have the best particle morphology.

Yield of microcapsules: Analysis of variance showed that the ratio of maltodextrin to gelatin significantly affected the yield, of microcapsules. The average values of yield, moisture content, total phenolics and antioxidant activity of microcapsules are shown in Table 3.

Table 3: Yield, water content, total phenolic, and antioxidant activity of microcapsules of *Protium javanicum* leaf extract based on the ratio of maltodextrin to gelatin.

Treatment (M: G)	Yield (%)	Water Content (%)	Total Phenolic (mg GAE/g)	Antioxidant Activity (%)
MG1 (1: 1)	76.14 ± 0.12^{a}	2.84 ± 0.04^{a}	119.77 ± 0.78^{e}	86.10 ± 0.26^{e}
MG2 (1: 1.25)	79.75 ± 0.05^{b}	2.95 ± 0.02^{b}	117.58 ± 0.31^{d}	83.59 ± 0.98^{d}
MG3 (1: 1.5)	80.22 ± 0.04^{c}	3.15 ± 0.01^{c}	112.41 ± 0.32^{c}	78.92 ± 0.26^{c}
MG4 (1: 1.75)	82.87 ± 0.10^{d}	3.54 ± 0.005^{d}	105.68 ± 0.93^{b}	77.11 ± 0.36^{b}
MG5 (1: 2)	87.60 ± 0.06^{e}	4.25 ± 0.04^{e}	104.10 ± 0.48^{a}	74.19 ± 0.50^{a}

Description
M = Maltodextrin, G = Gelatin
Data shown as the mean value of 3 replicates ± standard deviation.
Different lowercase superscripts show a significant effect ($P<0.05$)

The yields of microcapsules ranged from 76.14% - 87.60%. The lowest yield was obtained from MG1 microcapsules with 76.14%, while the highest yield was obtained from MG5 microcapsules with 87.60%. The use of more gelatin results in higher yield microcapsules.
The microcapsule yield is the final product of microencapsulation, which is calculated based on the ratio between the weight of the microcapsule product obtained and the total weight of the solid material (encapsulating material and core material) and expressed as a percentage. A high yield means that the product produces more solids. Using more gelatin will increase the amount of microcapsule powder after the drying process, thus increasing the yield. The results of this study are in line with those reported by Xin *et al*. [35] that the higher the concentration of maltodextrin, the higher the yield of smoke powder food flavoring. Syah *et al*. [31] also reported that the increase in yield correlated positively with the increasing wall material concentrations used.

Water Content: The ratio of maltodextrin to gelatin had a significant effect on the water content of the microcapsules (Table 3). Increasing the amount of gelatin resulted in microcapsules with higher water content. The moisture content of the microcapsules in this study ranged from 2.84% to 4.25%. The lowest moisture content was obtained from MG1 microcapsules, while the highest moisture content was obtained from MG5 microcapsules.
The moisture content of microcapsules affects tackiness, flowability, water activity, drying efficiency, microbial development and oxidation of bioactive ingredients. Additionally, the moisture content of the microcapsule can impact the stability of storage because, at greater moisture levels, the wall material transforms from a glassy state to an amorphous rubbery state, which causes the core material to degrade and release during storage [14].
Gelatin is a biopolymer composed mainly of protein (85-92%), mineral salts and water [8]. According to the Gelatin Manufacturers Institute of America / GMIA, commercial gelatin has a moisture content of 8%-13% and a relative density of 1.3-1.4, while commercial maltodextrin has a moisture content of 2.09%-6.47% [32]. In the process of microencapsulation by lyophilization, an increase in the concentration of protein in solution can induce aggregation during the freezing process and make interstitial water less available for freezing [19], thus increasing the water content of the encapsulate. The results of this study are consistent with those reported by Malacrida *et al*. [18] that turmeric oleoresin microcapsules with modified starch and gelatin have different moisture contents. The higher the use of gelatin, the higher the moisture content of turmeric oleoresin microcapsules. Ezhilarasi *et al*. [9] also reported that that increasing the concentration of whey protein concentrate in the microcapsule solution resulted in higher moisture content of garcinia fruit extract microcapsules.

Total phenolic content: The total phenolic content of the microcapsules was lower than the total phenolic content of the extract. Based on the data in Table 3, it has been determined that the total phenolic content of the microcapsules ranged from 104.10 mg GAE/g to 119.77 mg GAE/g. The lowest total phenolic content was obtained from MG5 microcapsules, while the highest total phenolic content was obtained from MG1 microcapsules.
The total phenolic content of the microcapsules was lower than the total phenolic content of the extract. A number of complex factors contributed to the hammering of polyphenol compounds during the freeze-drying process. Crushing the lyophilized microencapsulated products following the freeze-drying process was thought to be one of the main factors that could accelerate the degradation of bioactive components in the final products by increasing their contact with the environment [10]. The formation of microspheres during lyophilization as a result of the bioactive components scattering inside the configuration of encapsulating wall materials, i.e., consisting of one or more constant phases of encapsulating agents [17], and the development of micro-pores in the aforementioned microspheres, which are primarily related to the sublimation process during lyophilization, are additional factors that may be responsible for the decline in the concentration of active components [26].
The results of this study are consistent with those reported by Ballesteros *et al*. [5] that there was a decrease in the total phenol content of spent coffee grounds after encapsulation by freeze drying method. Kuck and Noreña, [16] also reported that microencapsulation by freeze-drying method resulted in lower total phenol content of grape skin microcapsules compared to the total phenol content of the extract. On the other hand, Hussain *et al*. [10] revealed that the freeze-dried polyherbal product showed a decrease of 5.72-31.78% in total phenol content. In addition, a decreasing trend of 23.54-59.65% and 20.76-40.30% was observed for total flavonoid content and total condensed tannins, respectively.
Total phenolic content in microcapsules is correlated with their antioxidant activity. The results of this study are consistent with those reported by Siregar and Kristanti [30], who found that microcapsules of ethanolic extract of *Cosmos caudatus* with higher total phenolic content had higher antioxidant activity.

Antioxidant Activity: Based on the data in Table 3, it appears that there is a decrease in antioxidant activity of microcapsules as the ratio of maltodextrin to gelatin increases. The antioxidant activity of the microcapsules ranged from 74.19% to 86.10%. The highest antioxidant activity was obtained from MG1 microcapsules, while the lowest antioxidant activity was obtained from MG5 microcapsules. The total phenolic content of the microcapsules is responsible for their antioxidant activity. Correlation analysis between total phenolics of microcapsules and antioxidant activity showed that there was a strong positive correlation between total phenolics and antioxidant activity as indicated by R^2 value of 0.94 (Figure 2).

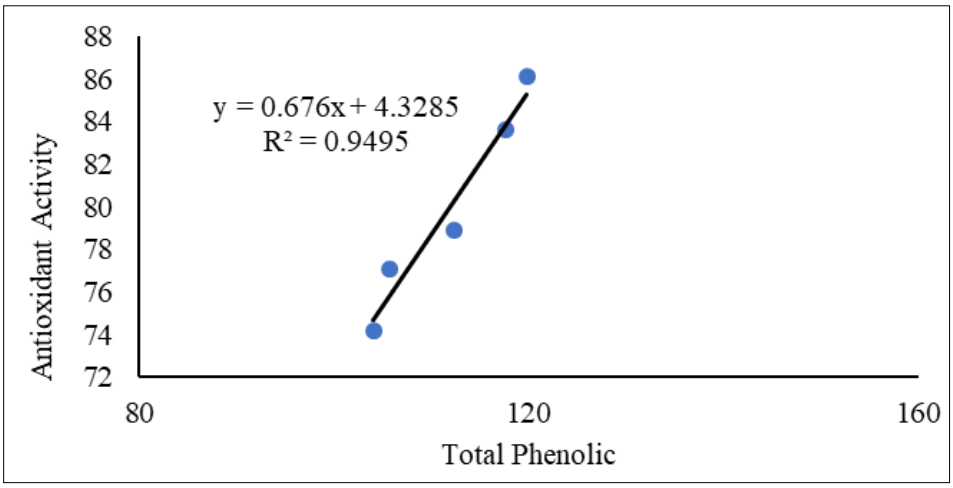

Fig 2: Correlation graph between total phenolics and antioxidant activity

Conclusion

The comparison of maltodextrin and gelatin had a significant effect on the physical and chemical properties of *Protium javanicum* leaf extract microcapsules. Morphological analysis by SEM showed that the use of maltodextrin and gelatin at 1:1 ratio resulted in smooth particle morphology with few rough parts and few voids. The highest total phenolic content, antioxidant activity, and encapsulation efficiency were obtained from microcapsules containing maltodextrin and gelatin at 1:1 ratio. The highest water content and yield were obtained from microcapsules containing maltodextrin and gelatin in a ratio of 1:2. The determination of the best microcapsules is based on the highest encapsulation efficiency value as well as the absence of cracks on the microcapsule surface. Thus, the use of maltodextrin and gelatin in the ratio of 1:1 for the microencapsulation of *Protium javanicum* leaf extract was able to produce microcapsules with the best characteristics.

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