Chapter

Microencapsulation Techniques of Herbal Compounds for Raw Materials in Food Industry, Cosmetics and Pharmaceuticals

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Abstract

Microencapsulation is a technique or process of wrapping very small gas particles, gases, or active solid content with a coating material/membrane to protect the active particles (core) from environmental influences like unwanted effects such as light, moisture, and oxygen to increase shelf life of the product. Microencapsulation proposes to protect sensitive food components, reduce nutritional losses, expand the usefulness of sensitive food components, add certain food to other food, protect flavors and fragrances, convert liquid food components to more convenient solids handled, and protect materials from environmental influences. Product microcapsulation can be used as raw material for the food industry, cosmetics, and pharmaceuticals using bioactive compounds. From the results of the curcuminoid content testings, it can be observed that an increase of drying temperature produces lower amount of curcuminoid contents, which is caused by the inability of curcuminoid compounds to be preserved by maltodextrin, as the microencapsulant. The best temperature to preserve curcuminoid compounds is at 110°C, in which 10.52% is preserved. Hence, for *Aloe vera* processing, the optimum drying temperature was 120°C which maintained the active component of *Aloe vera* powder such as *Aloenin (B)*, *Aloeresin A*, and *Chrysophanol*.

Keywords: microencapsulation, herbal compounds, maltodextrin, *Aloe vera*, cosmetics

1. Introduction

Microencapsulation is an encapsulation technique or process of very small gas particle, gas, or active solid substance with coating/membrane materials with the purpose of protecting the active particle (core) from unwanted environmental influences, such as radiation, humidity, and oxidation to increase shelf life [1]. These capsules are measured in one (1) micron (1/1000 mm) to seven (7) mm, and release their contents at a measured time according to their applications [2].

Microencapsulation aims to protect sensitive food particle, reduce loss of nutrition, expand the uses of sensitive food material, add certain food particles into other food materials, protect tastes and aroma, modify the state of food material from liquid to solid for ease of handling, and protect food particles from environmental effects. Protection provided by microencapsulation can also prevent degradation caused by radiation or oxidation, and also slow down evaporation on volatile compounds [3].

The results of a microencapsulation process are microcapsules containing an active compounds or raw materials surrounded by membrane or cell. The material encapsulated is usually referred to as the core, internal phase, or insert. The coating material is called coat, encapsulant, or shell with varied number and thickness. Coat, shell, encapsulant, or wall is designed to protect the core from destructive factors such as radiation, oxygen, and humidity. In microencapsulation, capsule is designed and prepared to achieve all the needs considering the natures of the core or coating materials, the desired usage of the material, and storage condition [2].

Encapsulants from carbohydrates, such as maltodextrin, starch, and arabic/acacia gum are widely used. However, these materials generally have weak surface tension and require modification or are used with agents with active surface tension to encapsulate oil-based substances [4].

There are four mechanisms of core release from microcapsules: degradation, dissolution, and melting of capsule walls, and diffusion of core materials through broken shell. Abrasion (slow erosion of capsule shell) and biodegradation are two other mechanisms that are less frequently employed [5].

The use of microencapsulation technology has been applied in many fields, such as drug encapsulation in the pharmaceutical industry, adhesive materials, agrochemicals, live cells, catalysts, vitamin storage, and so on. The advantages of microencapsulation are handling liquid as solid, preserving aroma or taste effectively in the food industry, protecting core substances from detrimental effects of the environment, safe handling of toxic materials, and controlling the delivery of drugs [2].

The benefits of microencapsulations are preserving the functions of active compounds, extending shelf life, covering unpleasant taste or aroma (unpleasant taste but high benefits), facilitating handling, facilitating control, improving appearance, and improving taste and colors. Microencapsulation can be prepared by emulsified coating or fluidized bed coating. Microencapsulation process with spray dryer method consists of two phases: oil emulsification in polymer solution and solvent removal using hot air. The polymers used are from many kinds of polysaccharides and proteins, such as starch, arabic gum, gelatin, albumin, and casein [4].

In an emulsification, emulsion is formed when minute oil droplets are dispersed in an emulsifier, in this case a polymer. Emulsion is a mixture system containing two immiscible liquid phases, in which one phase is dispersed in the other phase in the form of droplets. Almost in all food products, the diameters of the droplets range from 0.1 to 100μm. Emulsion is an unstable system in which the phases tend to separate. In an emulsion system consisting of pure oil and pure water, it is easy to for two layers based on the difference in densities. This phenomenon is caused by the tendency of the droplets to combine with nearby droplets and often produce a perfect separation. As such, stability is one of important factors in the encapsulation process using spray dryer. The process to make two immiscible solutions form an emulsion is called homogenization and

the mechanism to perform this process is called homogenizer. To differentiate between the natural state from the initial components, homogenization can be more appropriately categorized as primary (emulsion formation) and secondary homogenizations (droplet size reduction) [4].

In almost all microcapsules, the coating materials are usually made of organic polymers, although wax and fats have been used, especially in the uses for food and pharmaceutical products, the coating materials have to meet the specifications required by the FDA [4].

Microencapsulation process can be performed with several techniques, such as spray drying, spray cooling, extrusion, and coacervation [3]. Out of those four methods, spray drying is most frequently employed. Spray drying has become the most important method in the water removal process (dehydration) for liquid food products in the western world. This dehydrator is a diabetic dehydrator, and there are many considerations on solid-state diabetic dehydrator that can be applied. This process is a conversion from a liquid state into dry particles by spraying materials into the hot dehydrating medium. The dry products from this dehydrating process can be in the forms of powder, granules, or clumps. In this drying process, the products are not placed in drying cabinets or shelves, but dispersed as fine droplets suspended in the air inside the dryer. The advantages of this method are that the technology is well known thus easily obtained; it can be used to produce capsules in large quantities, the coating materials for spray drying are approved as food products, and the coating materials dissolve in water and can release the core without leaving residue. Efendi stated that microencapsulation with spray dryer should utilize encapsulant materials with high solubility, emulsion-forming capability, layer-forming capability, dry, and low viscosity [5]. Even though several encapsulants can be used in nonfood materials, those for food products are limited to natural gum, carbohydrates, maltodextrin, wax, and several proteins.

Drying with spray dryer is performed by spraying the materials to be dried as mists, which increases the surface area of the materials to be in contact with the drying medium, thus the water evaporation process can proceed well. The spraying process is influenced by the form of the sprayer, speed of product flow, and product characteristics [6].

The spray dryer process consists of four stages: (1) atomization, in which liquid or paste is converted into mists, (2) contact between the atomized materials with hot air, (3) water evaporation from the materials to reach the desired moister content, and (4) product collection in a powder form. In the stages of spray drying process, there are several operational units consisting of preconcentrated solution, atomization (mist formation), drying using dry and hot air, separation of powder from water vapor, cooling, and product packaging.

2. Microencapsulation process of *turmeric* (*Curcuma domestica Val.)*

Turmeric (*Curcuma domestica Val*.) is a type of rhizoma medicinal plant containing curcuminoids, which consist of curcumin compound and its derivatives, desomethoxycurcumin and bis-desomethoxycurcumin. Curcuminoid is an active compound from *turmeric* rhizome that has biological activities with a wide application such as antihepatotoxic [7]. *Turmeric* has been known and used by the wider public, in the urban and rural areas, especially at homes, because of its wide usage. Part of *turmeric* used is the roots or rhizome, which is frequently

used as organic fabric coloring, food flavoring, spices, and cosmetic materials. *Turmeric* is also used as traditional medicine for itching, gum inflammation, wounds, breathing shortness, stomachache, boils, skin fungal infection, back pain, jaundice, bad digestion, diarrhea, toxin neutralizer, low appetite, and so on [8].

Microencapsulation is a coating technology for solid, liquid, and gas using capsules in minute form, in which those capsules can release the core under specific conditions. Microencapsulation aims to protect sensitive components, reduce nutrient loss, and add food products in liquid form to solid form for ease of handling [9].

In this study, the microencapsulation process uses spray drying, which is the most frequently employed in the food industry because of its relatively lower cost. The advantages of this process are flexible and can be used for a variety of materials in microencapsulation because the equipment can be applied to process various materials and produce good quality particles with a consistent distribution of particle size. The food materials that can be applied in this method include fats, oils, and flavor enhancers. The coating can be from carbohydrates, such as dextrin, sugar, starch, and gum, or proteins, such as gelatin and soy proteins. Microencapsulation process includes emulsion formation or suspension on the active compounds and coating, and atomization of the emulsion into circulated dry and hot air inside drying chamber using an atomizer or a nozzle. The water contents inside emulsion droplets evaporate. The solid left over from the coating material traps the core material. Spray drying is useful for food materials that are sensitive to heat because the drying process occurs very fast. The other advantages of spray drying are the variety and availability of equipment, microcapsule quality that stays high, variety of particle size that can be produced, and good dispersibility in liquid media. However, loss still happens to active compounds with low boiling point. Physical characteristics of microcapsules depend on hot air (about 150–200°C), degree and uniformity during emulsion atomization, degree of emulsion density (30–70%), and emulsion temperature. The other disadvantages are the loss of bioactive compounds with low boiling point, oxidation in flavor enhancer substances, and limited options for shell materials, in which these materials can dissolve in water in an adequate amount. The flow diagram for microencapsulation process for *turmeric* to produce *turmeric* powder is presented in **Figure 1**.

This study was conducted to determine the optimal temperature of the inlet (T*inlet*) drying of the spray dryer to produce *turmeric* powder. *Turmeric* concentrate at 300 ml is added with 10% maltodextrin as microencapsulant; then, it was homogenized. The sample was homogenized using a magnetic stirrer to keep homogenized throughout the spray drying process. This process was taken into the spray dryer *SD-basic LabPlant*. Data were obtained from the same amount of volume but at different T*inlets* of 100, 120, 130, 140, 150°C, while the T*outlets* are recorded at 80–100°C, P (*blower*) at 4 m^3/mm, and feed flow at 0.6 ml/s. The yield of microencapsulation was calculated with definition reported by [10]. The microencapsulation yield was defined as percentage of total *turmeric* dried powder and the mass of the total *turmeric* liquid fed to spray dryer. The microencapsulation yield of *turmeric* powder drying at varied drying temperatures is given in **Table 1**.

In this study, the *turmeric* powder was produced by varying the T*inlet* on the spray dryer at five points of temperature, i.e., 100, 120, 130, 140, and 150°C. The samples contain 300 ml of *turmeric* concentrate and 10% maltodextrin [11].

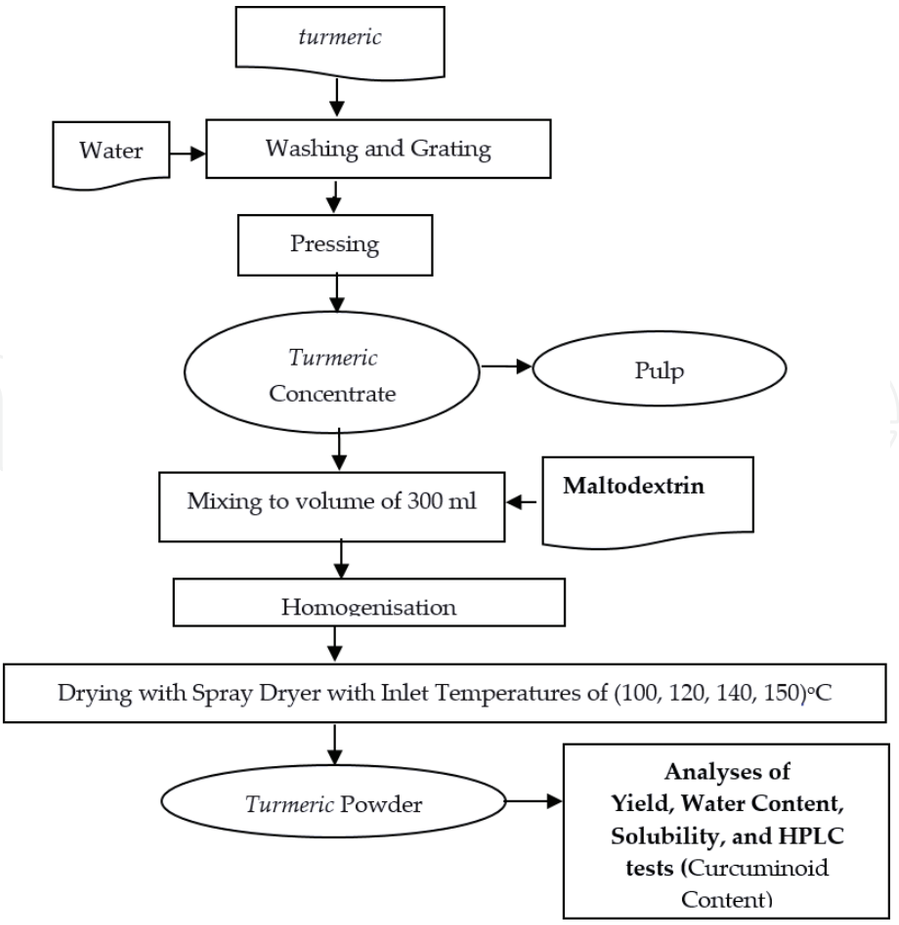


Figure 1.
Flow diagram of microencapsulation process transforming turmeric to turmeric powder [13].

No.	Samples for varied T*inlet* (b)	T*inlet spray dryer* (°C)	*Turmeric* concentrate (ml)	Drying time (s)	Yield (w/v) (%)
1	Sample I	110	300	480	2.64
2	Sample II	120	300	475	3.05
3	Sample III	130	300	478	3.31
4	Sample IV	140	300	460	3.69
5	Sample V	150	300	455	4.32

Table 1.
The study results of turmeric *powder drying time and yields at varied T*inlet *on the spray dryer, using 10% maltodextrin.*

Based on the results shown in **Table 1**, the increased drying temperature (T*inlet*) reduces drying time, while increases yields. This study showed that at temperature of 150°C, the drying time took place at 455 s (7 min, 35 s) and produced 4.32% yield. The higher the T*inlet* spray dryer, the shorter the drying time. To obtain the optimum operation condition, it should observe also the curcuminoid content from **Table 4**.

This outcome is caused by higher the drying temperature, faster the water evaporation from the materials. The result of this study is supported by Estiasih et al. [6], where there is a difference of temperatures between heating medium and materials, in which the faster the heat transfers to the materials, the faster the water

evaporates from them. As such, it can be understood that the higher the temperature used in the drying process, the shorter the drying time. However, it takes longer time for the spray dryer to reach higher temperatures.

The *turmeric* powder resulting from the spray drying process is tested for water content, solubility, and yield. The results of these tests are presented in **Table 2**. From this table, it can be seen that the water content, solubility, and yields of *turmeric* powder are affected by T*inlet* on the spray dryer equipment.

Water content analyses are performed to determine the water content of the powder produced from the spray dryer because water content influences shelf life, appearance, and water solubility. An increase of drying temperatures will reduce water content in the product. Water content testing is a part of quality testing on the *turmeric* powder and is conducted by heating at 105°C for 3 h, as described in SNI 01-2891-1992 on testing of food and beverage. The results of water content testing are presented in **Table 3**.

Based on **Figure 2**, an increase of drying temperature would reduce the water content of the product. This is because drying temperature has a role in water evaporation from the materials. And thus, the higher the temperature, the more water will evaporate, and the less water is left in the product.

Solubility is an important factor in powder product testing. Powder solubility is determined by composition, conditions during drying process, solvent temperatures, and mixing method. The higher the drying temperature, the less the water content in the products. The solubility testing is conducted by dissolving the *turmeric* powder samples produced at different T*inlets* in water at 100°C and recording the dissolving time in seconds. The effect of different T*inlets* of the spray dryer on the solubility of *turmeric* powder is presented in **Figure 3**.

As shown in **Figure 3**, the yields from a drying process are determined by the amount of the resulting products. In this study, the yields range from 1 to 4.42%, which means that the yields are relatively low compared to the initial dry materials

No.	Samples from different T*inlet* (b)	T*inlet* spray dryer (°C)	Water content (w/v) (%)	Dissolving time (s)
1	Sample I	100	8.5	492
2	Sample II	120	5.85	497
3	Sample III	130	4.15	520
4	Sample IV	140	4	532
5	Sample V	150	2.65	592

Table 2.
Test results on water contents and solubility of turmeric *powder produced at different temperatures of T*inlet *on the spray dryer, using 10% maltodextrin.*

No.	T*inlet* spray dryer (°C)	*Turmeric* powder water content (%w/v)
1	110	8.5
2	120	5.85
3	130	4.15
4	140	4
5	150	2.65

Table 3.
Results of water content testing on turmeric *powder produced at different drying temperatures.*

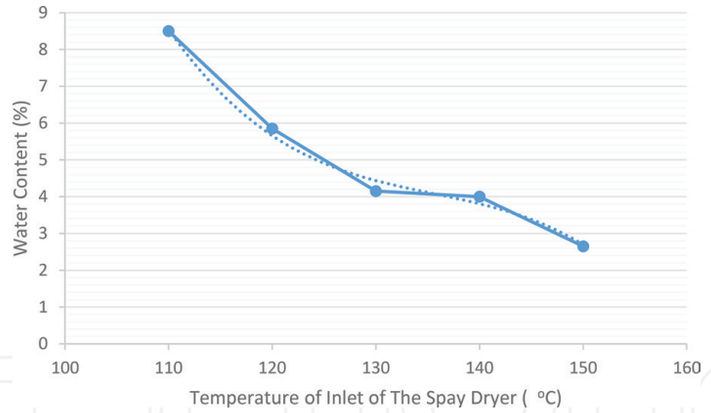


Figure 2.
The effects of temperature of inlet of spray dryer or drying temperature on the water content of turmeric *powder.*

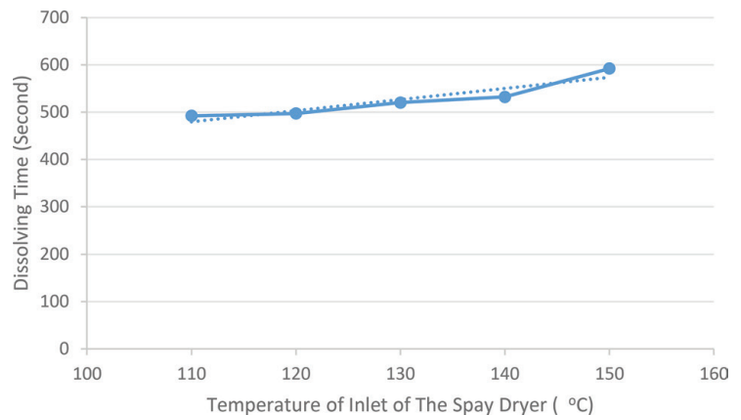


Figure 3.
The effects of temperature of inlet of spray dryer or drying temperature on the solubility of turmeric *powder.*

that are inserted in the spray dryer in liquid forms. In a drying process, free water molecules on the surface of the material particles can be easily evaporated, which produce low yields. However, based on the drying temperature variables, as presented in **Table 4**, the higher the drying temperature, the higher is the yield. It can be noted that the highest yield is found at the temperature of 150°C, and the effect of different T*inlet* on yields is presented in **Figure 4**.

Based on **Figure 4**, the effects of drying temperatures can be explained by an increase of temperatures causing dryer particles, which leads to less materials sticking inside the dryer and more getting collected in the cyclone vacuum collector. With an increase of temperatures, the yields obtained increase, and in this study, the highest yield is obtained from 150°C drying temperature at 4%. At the drying temperature of 100°C, the yield is relatively low at only 2.64%. The results of this study show that the drying temperatures have a positive correlation with the yields, such that when temperature is raised up to 150°C, the yields also increase because more materials are collected in the cyclone vacuum collector.

The results from HPLC testing are used to show curcuminoid contents in the *turmeric* powder samples and are presented in **Table 4**.

From the results of the curcuminoid content testing, it can be observed that an increase of drying temperature produces lower amount of curcuminoid contents, which is caused by the inability of curcuminoid compounds to be preserved by maltodextrin, as the microencapsulant. The best temperature to preserve curcuminoid compounds is at 110°C, in which 10.52% is preserved, although the yield was lower and drying timer was longer than 150°C.

Sample code	T*inlet* of spray dryer (°C)	Bis-demethoxycurcumin content (%)	Demethoxycurcumin content (%)	Curcumin content (%)	Total curcuminoid content (%)
Sample I	110	0.32	2.53	7.67	10.52
Sample II	120	0.22	1.20	3.63	5.05
Sample III [*13]	130	0.09	0.70	2.22	3.01
Sample IV	140	0.08	0.64	2.04	2.75
Sample V	150	0.07	0.29	1.29	1.65

Table 4.
*The results of HPLC on the curcuminoid contents *[13].*

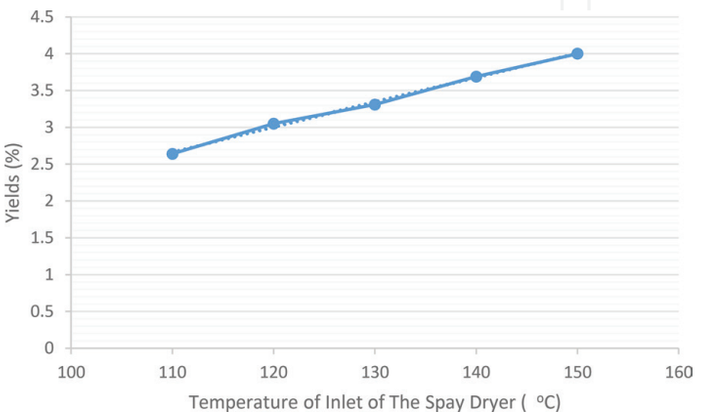
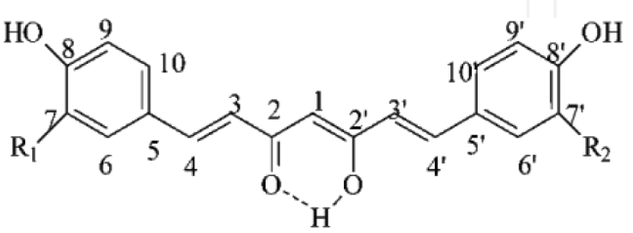


Figure 4.
The effects of temperature of inlet of spray dryer or drying temperature on the yields of turmeric *powder.*

Based on research results, *turmeric* contains many chemical substances that are useful for human body. Several chemical contents from *turmeric* rhizome that have been identified are essential oils at 6% consisting of monoterpenes and sesquiterpenes (zingiberene, alpha- and beta-turmerones), yellow coloring call curcuminoid at 5% (consisting of curcumin 50–60%, mono-desmethoxycurcumin, and bi-desmethoxycurcumin), proteins, phosphorus, potassium, iron, and vitamin C. Out of those three curcuminoid compounds, curcumin makes up the largest amount and one of its functions is to increase appetite in children (**Figures 5** and **6**).

The following figure shows the resulting chromatograms from the HPLC testings on sample V.



Compound	R1	R2
Curcumin (**1**)	OMe	OMe
Demethoxycurcumin (**2**)	H	OMe
Bisdemethoxycurcumin (**3**)	H	H

Figure 5.
Chemical structure of curcuminoid [12, 23].

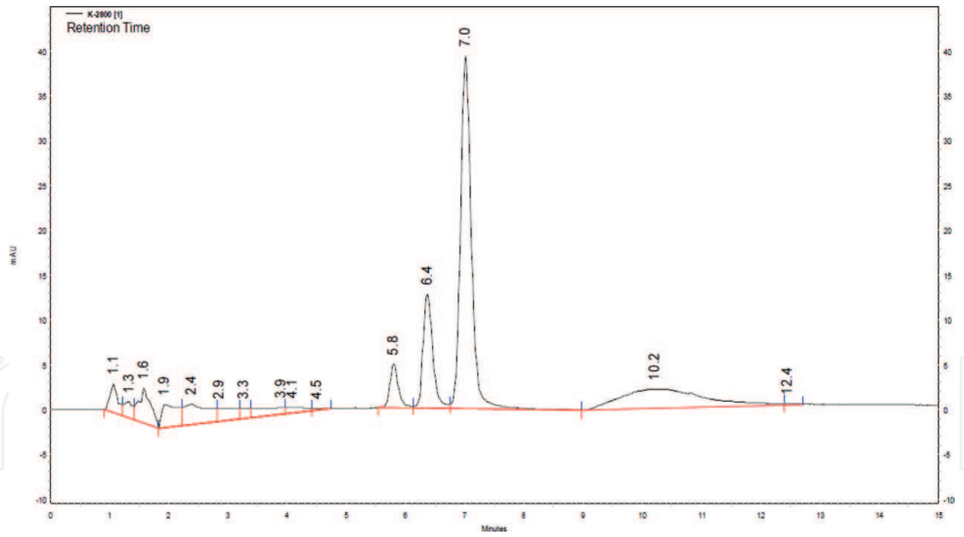


Figure 6.
Chromatograms of curcumin powder on sample I.

3. Microencapsulation process on *Aloe vera* (*Aloe chinensis Baker*)

Aloe vera plant is categorized as a low shrub, with succulent characteristics, and suitable for dry regions. The stem is short with the leaves forming a rosette around the stem and bell-shaped flowers. The leaves, which are the main parts to be utilized, have the lengths of 40–90 cm, widths of 6–13 cm, and thickness of 2.5 cm at the base. The variety that is generally cultivated in Asia, including Indonesia, is *Aloe chinensis* Baker, as described by Baker in 1977, which was developed in but is not native to China. This variety has been commercially grown in Indonesia, especially in the province of Kalimantan Barat (West Kalimantan) and more locally known as *Aloe vera* Pontianak [15–17].

The highly perishable nature of *Aloe vera* gel has prompted some efforts to process the gel harvest into powder. The aims are not only to preserve the contents of the gel, but also to increase the value of the harvest. So, *Aloe vera* is not just sold in fresh leaves, which usually are priced relatively low [15].

Furnawanthi [15] stated that *Aloe vera* in powder form also has other advantages: preserved nutrient contents, longer shelf life, and efficient transport. The raw material to powder ratio is around 150:1, which means that to obtain 1 kg of powder, 150 kg of fresh leaves are needed. As such, the establishment of *Aloe vera* powder industry requires a large amount of raw materials. This industry can also minimize the possibility of detrimental price drops that are often caused by overproduction and storage limitations of *Aloe vera* farmers. *Aloe vera* has high water contents and appears to be challenging to convert into powder. However, considering the contents of beneficial active compounds, several milling methods have been conducted to obtain those active compounds. The milling or drying technique frequently used is spray drying, whereas the common method is microencapsulation. Production of *Aloe vera* powder consists of two stages, which are (1) production of cores for *Aloe vera* powder and (2) drying with spray dryer. *Aloe vera* gel is crushed, blended, filtered, and vacuum evaporated to produce *Aloe vera* powder core. Microencapsulation uses maltodextrin as microencapsulant in a spray drying process. *Aloe vera* processing produces wastes in the form of rinds/pulp in a large amount. *Aloe vera* rinds are rich in organic materials or cellulose or pectic, and they can cause pollution problems if not managed. One of the waste managements is to use the by-products to make *Aloe vera* tea, livestock feed, and organic/composted fertilizer that is eco-friendly.

The procedures to produce *Aloe vera* powder were the following: (1) the *Aloe vera* was peeled and taken the gel, manually using knife; (2) the *Aloe vera* gel was crushed using blender. Then, it was filtrated using manual filter press, the filtrate was collected, and the pulp was thrown away; (3) the filtrate of *Aloe vera* was evaporated (40 times) using rotary vacuum evaporation (volume 8 lt) to get core of gel at temperature 35–40°C and vacuum condition (75–100 mbar); (4) the core of *Aloe vera* taken from evaporation was mixed with maltodextrin as filler and then it was mixed well using homogenizer with 1:1 composition between the core and maltodextrin. Then, it was homogenized until its concentration 50 °Brix (40–60 °Brix); and (5) In this research [17], the drying was conducted using spray drier. The hot air was introduced cocurrent with feed stream. In this stage, it was obtained the optimum variable process for drying to get active compound still maintained. The optimization was conducted to obtain the optimum drying temperature corresponding to desired quality of product or product in the market. To approach this, the drying temperature was varied: 110, 120, 130, and 140°C [17]. Mass flow diagram of *Aloe vera* powder production from the initial mass of 100 kg of *Aloe vera* leaves is presented in **Figure 7**.

To obtain the optimum drying temperature, the optimization was conducted to preserve the active compounds corresponding to commercial *Aloe vera* powder. The optimization was carried out at 110, 120, 130, and 140°C drying temperatures. The result shows that the density was almost same respectively to the commercial products (Terry Labs' product). Hence, the water content was below the commercial product. The water content was 2.88–4.89% w/w in which the commercial product is 8% max. This might be because of drying process. In the cocurrent spray dryer, the hot air is contacted with the feed in the same stream; it means that the highest temperature of hot air meets with the first feed stream. The microencapsulated active components have been affected by high temperature of dryer; on the other hand, it was relatively stable at lower temperature. It means that the quality of product has been affected by temperature of dryer. To analyze the chromatography result, an LC-MS method was conducted at absorbance of 254 mm for *Aloe vera* gel powder concentrates achieved from evaporation process, and the *Aloe vera* powder after 110, 120, 130, and 140°C drying temperatures. The result shows that *Aloin* A and B, *Aloenin* (B), *aloesin*, and *Chrysophanol* were appeared in all samples. Although *Aloe-emodin* was not detected in all samples, *Aloeresin* A was appeared in evaporated *Aloe vera* gel and *Aloe vera* powder (110 and 120°C drying temperature). Based on the result, the optimum drying temperature was 120°C to produce *Aloe vera* powder where all of phenolic compounds of *Aloe vera* powder was still maintained [17].

The *Aloe vera* powder from fresh *Aloe vera* leaves was analyzed for the microbiology, water content, density, solubility, pH, particle, color, and active component using LC-MS. The properties of *Aloe vera* powder obtained from the research for dryer temperature variation were described in **Table 5**. It was compared with the standard commercial *Aloe vera* powder from Terry Labs.

In general, the resulting product has met most of the parameters and specifications of commercial *Aloe vera* powder on the market such as water content, solubility, color, pH, appearance, and microbiology. **Table 5** shows that drying with higher temperatures resulting in *Aloe vera* powder products with microorganism contamination levels is lower even though the four variables still eligible.

While the product is almost the same density compared to available commercial products, this might be due to the method of testing using different methods, so the result is somewhat different. The testing methods used packed density. In the drying process (spray dryer), the decreasing of hot air inlet temperature did not affect the increase of water content significantly. In fact, water content tended

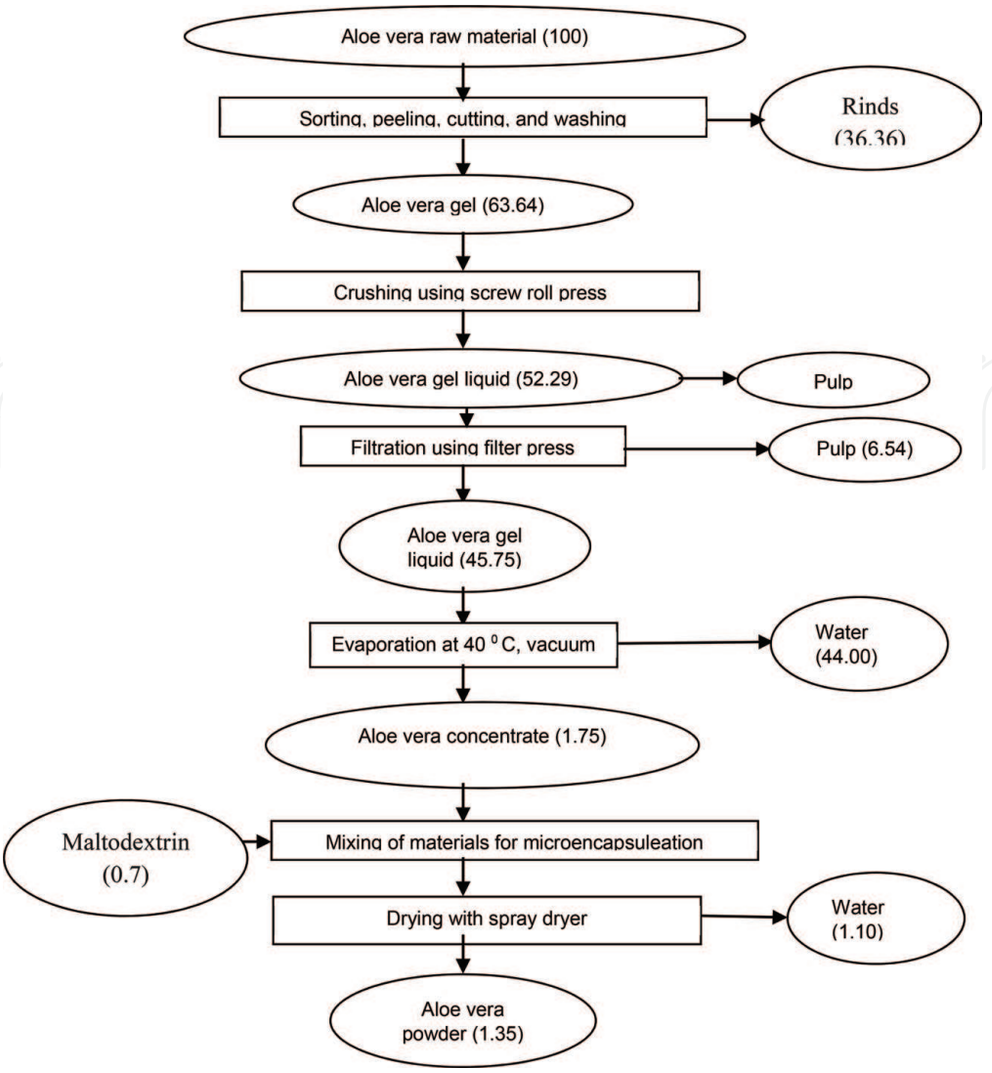


Figure 7.
Mass flow diagram of Aloe vera powder production from the initial mass of 100 kg of Aloe vera leaves.

No.	Compounds	*Aloe vera* powder 1 (140°C)	*Aloe vera* powder 2 (130°C)	*Aloe vera* powder 3 (120°C)	*Aloe vera* powder 4 (110°C)	*Aloe vera* powder spray-dried gel (Terry Labs' product)
1	Water content (% w/w)	2.88	4.04	4.89	4.89	8% max
2	pH	4.98	4.99	4.97	4.98	3.5–5.0
3	Microbiology (cfu/g)	96	97	97	98	<100
4	Density (g/ml)	0.99	0.99	1.00	1.00	0.990–1010
5	Solubility (min)	2.26	1.93	2.94	2.94	5
6	Color	Beige white	Beige white	Beige white	Beige white	Beige white
7	Appearance	Fine	Fine	Fine	Fine	*Fine crystalline powder*

Table 5.
The properties of ***Aloe vera*** *powder obtained [17].*

No	Specifications	Spray-dried aloe gel powder	No	Specifications (amino acid contents)	Spray-dried aloe gel powder, ppm
1	Amylase activities	0.024 unit/gr sample	1	Aspartic acid	131.71
2	Cellulose	0.0197%	2	Glutamic acid	153.12
3	Lignin	0.0089%	3	Serine	88.25
4	Saponin	Confirmed presence (qualitative test)	4	Glycine	72.78
5	Glucose	48.45 ppm	5	Histidine	155.23
6	Calcium (Ca)	0.93%	6	Arginine	135.92
7	Magnesium (Mg)	0.13%	7	Threonine	155.93
8	Phosphor	37.3 ppm	8	Alanine*	65.94
9	Lead (Pb)	<0.02 ppm	9	Proline	132.11
10	Arsenic (As_2O_3)	<0.005 ppm	10	Tyrosine	242.98
11	Zn	0.05%	11	Valine*	127.39
12	Natrium (Na)	0.73%	12	Methionine*	192.79
13	Kalium (K)	0.51%	13	Cysteine	106.29
			14	Isoleucine*	223.26
			15	Leucine*	166.01
			16	Phenylalanine*	124.08
			17	Lysine*	174.24

*Essential amino acid.

Table 6.
The results of chemical analyses on the contents of Spray-dried aloe gel powder [14, 15].

to be stable of 2–5%. This has a positive effect for the quality of product in which the active component microencapsulated was relatively stable for lower temperature of dryer.

The results of chemical and content analyses of active compounds in *Aloe vera* powder are presented in **Table 6**. From these results, it can be determined that *Aloe vera* powder can be used in cosmetics, pharmaceutical, and food industries. In these industries, the functions of these bioactive compounds must be preserved. The lignin and saponin contents make *Aloe vera* powder very suitable for skin care formulations, such as lotion, wash, shampoo, and soap. The contents of active compounds in *Aloe vera* powder are complete with proteins, polysaccharides, lignin, saponin, and minerals, and can be incorporated into formulations for topical applications, such as anti-plaque toothpaste, shampoo, soap, lotion, sunscreen, and burn cream; whereas for internal uses, *Aloe vera* powder can be used as diabetic medication, because of its high polysaccharide content, and dietary and health supplements [18–23].

4. Conclusion

Microencapsulation proposes to protect sensitive food components, reduce nutritional losses, expand the usefulness of sensitive food components, add certain food to other food, protect flavors and fragrances, convert liquid food components

to more convenient solids handled and protected materials from environmental influences. Product microcapsulation can be used as raw material for the food industry, cosmetics, and pharmaceuticals, using bioactive compounds. From the results of the curcuminoid content testings, it can be observed that an increase of drying temperature produces lower amount of curcuminoid contents, which is caused by the inability of curcuminoid compounds to be preserved by maltodextrin, as the microencapsulant. The best temperature to preserve curcuminoid compounds is at 110°C, in which 10.52% is preserved. Hence, for *Aloe vera* processing, the optimum drying temperature was 120°C which maintained the active component of *Aloe vera* powder. The result of LC-MS observed that the active components of *Aloe vera* powder can be maintained at the optimum operation condition of drying. The optimum drying temperature was 120°C, which was the active component of *Aloe vera* powder such as *Aloenin (B)*, *Aloeresin A*, and *Chrysophanol* still maintained.

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