CHARACTERISTICS AND QUALITY OF THE FREEZE-DRIED INDONESIAN TRADITIONAL HERB MEDICINE

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ABSTRACTS

The demand on traditional herb medicine (jamu in Indonesia) shows a tremendous increase. Until then recent years, the jamu drying is accomplished by conventional methods, which cause quality deterioration due to the high temperature application. This experiment is aimed to study the freeze drying characteristics of the herb medicine, and to asses the quality of the freeze dried products.

The experimental results show that higher chamber pressure or faster freezing rate tends to shorten the primary drying time but lengthen the secondary drying time. The quality of the freeze-dried product was slightly lower than the quality of the raw material, but there was a tendency of higher solute content in water, which is accounted for the hydro-diffusion nature of the solute.

INTRODUCTION

Indonesia is bountiful with biodiversity, including those usable for medicinal herb. About 300 variety of the medicinal herb, out of more than 1000 known varieties, are commonly used as traditional medicine (Faroug, 1985). Among them, ginger (*Zingiber officionale*), and Javanese piper (*Piper retrofractum,* Vahl) are the most commonly used for the traditional herb medicine (jamu) in Indonesia, beside for flavourish. Ginger also shows a tremendous increasing demand for export commodity, either in form of volatile oil or powder.

Drying is very important for preserving the product and it is commonly performed with a high temperature drying (40-60 °C). The temperature sensitive of the active material in the product could not be preserved with the drying method, and thereby should be performed with freeze drying method. However, freeze drying is commonly known as a high cost drying method, due to its high energy consumption. In order to decrease the energy consumption, it is necessary to study the optimal drying condition while maintaining the high quality of the product.

Initial concentration of the product to be freeze-dried is an important factor in affecting the drying characteristic. Sagara (1984) showed that thermal conductivity of freeze dried coffee is higher if the initial concentration is high. However, material with higher concentration will have smaller porosity, which means lower permeability. The objective of this experiment is to study the characteristics and quality of freeze-dried the traditional herb medicine.

EXPERIMENTAL METHOD

The experiment was conducted using a laboratory scale freeze dryer equipped with a computerized data acquisition system. The sample holder was made of acrylic, cylindrically shaped, with diameter 9.5 cm and depth 1.5 cm (Figure 1). The sample holder was isolated around and at the bottom to assure the heat and mass transfer occurred in one direction, while the heat radiating plate was paced 13.5 cm above the sample surface. Thermocouple probes for measuring the temperature distribution within the product was arranged vertically at the center of the cylinder. During one cycle of the experiment, pressure inside the chamber and surface temperature of the product were controlled. Freezing before each cycle was accomplished by contact plate freezing method, and treated to obtain the low, medium and high freezing rate.

Selection of the product to be freeze dried was made according to the material most frequently used as ingredient for the most popular *jamu*. The material were small white ginger (*Zingiber officinale*) and Javanese piper (*Piper retrofractum*, Vahl). Before freeze dried, the each material was milled to make a pasta. The pasta form product is mostly preferred since the jamu is usually prepared in form of powder, and to eliminate the influence of shape configuration.

Freeze drying rate was evaluated using the thermal arrest time (TAR) concept, while the moisture content was measured using the Karl Fischer method. The quality of the freeze dried product was evaluated in laboratory to identify the remaining component and compared to either the Materia Medica Indonesia (MMI) standard or oven drying at normal temperature.

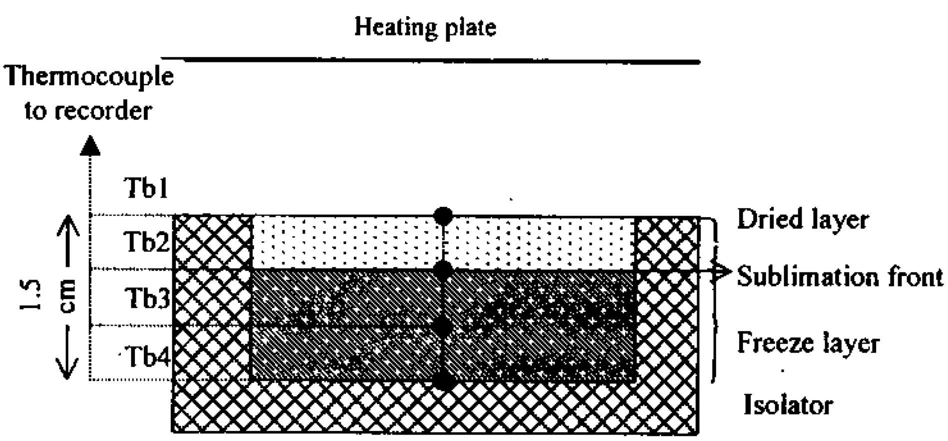

Figure 1. Sample holder and temperature measurement.

RESULTS AND DISCUSSIONS

Freeze Drying Characteristic

Figure 2 shows the measured temperature distribution during freezing and sublimation drying of Japanese piper. Freezing was fulfilled with a contact plate freezer with plate temperature about –42 °C to obtain the final temperature of the product about -32 °C. The figure shown was a sample for the medium freezing rate (2.7 cm/h) calculated with the TAR concept.

It was intended to fulfill the sublimation drying process right after the freezing, but it needed sometime to obtain necessary coldtrap temperature. The time lag made the product temperature increasing many degrees before decreasing again due to the air evacuation from the chamber. The re-freezing process proceeded until the product temperature reached the saturation temperature associated with the chamber pressure. It is important to assess the impact of the thawing and re-freezing process to the quality of the product, which is beyond the objectives of this experiment. This characteristics leads to the possibility of combining the freezing with the sublimation drying process in a chamber, utilizing a so called vacuum freezing process.

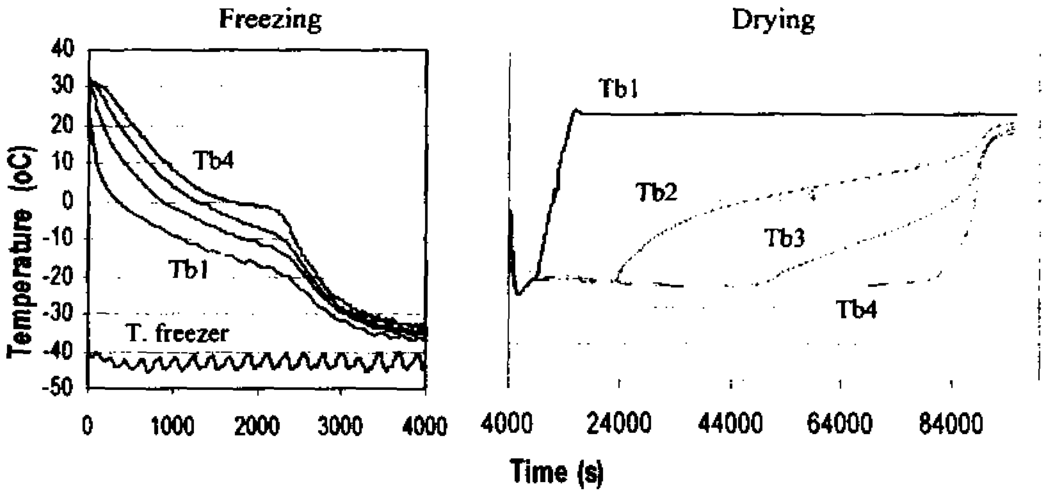

Figure 2. Temperature profile within the Javanese piper pasta during freezing and sublimation process (surface temperature 23.4 °C, chamber pressure 74.6 Pa, freezing rate 2.7 cm/s)

Commonly, the drying stage is separated into two drying periods, namely primary drying period and secondary drying period, by the time when temperature of the farthest point from the surface started to increase. Sublimation occurred mostly during the primary drying period, while the secondary period is used mostly for evacuation of water vapor from the pores of the dried layer. The theory can be used to explain the increase in drying rate during the secondary drying period depicted in Figure 3. The drying rate was obtained by differentiating the curve fitting of the

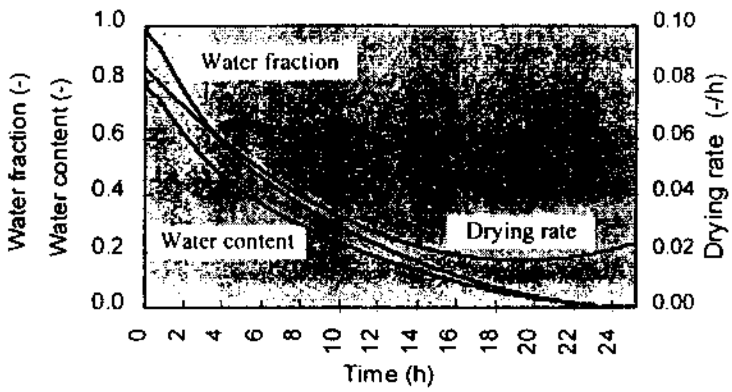

Figure 3. Changes in water content, water fraction and drying rate of Javanese piper under going freeze drying.

water content. Figure 3 also shows the changes in water content and water fraction within the Japanese piper during the freeze drying process.

Table 1 and Table 2 show the summary of the freeze-drying characteristic of Javanese piper and ginger, respectively. The data in Table 1 shows the effect of both chamber pressure freezing rate to the drying time, presented in the primary and secondary drying period. The higher chamber pressure tended to shorten the primary drying time but lengthen the secondary drying time. On the other hand, the faster freezing rate also tended to shorten the primary drying time, but lengthen the secondary drying time. It seems that the drying rate during the primary period is strongly influenced by the transport properties of the dried layer during freeze drying process. Higher chamber pressure yield in the higher thermal conductivity, which means faster transfer of heat from the surface of the product to the sublimation zone to be used for the sublimation process. Faster freezing rate is believed to construct a large number of smaller pores, on the contrary to the slower freezing rate. The large number of smaller pores seems to yield in higher value of permeability or transfer of water vapor to outside of the product being freeze-dried, compared to the few larger pores. Evacuation of water vapor from the pores during the secondary freeze drying period depends strongly to the vapor pressure gradient within the product.

The influence of surface temperature to the freeze-drying characteristic of ginger is shown in Table 2. The ginger was freeze dried at almost the same chamber pressure and level of freezing rate. It is as expected that the higher surface temperature will shorten the drying time, especially during the primary drying period. The effect of surface temperature to the secondary drying time was not clear. Even though the table shows a longer secondary drying time at the experiment on surface temperature 40 ^{o}C, it seems caused by the necessary time to equalize the bottom temperature with the surface temperature.

Tabel 1. Freeze-drying characteristics of *piper retr. Vahl*

Chamber pressure (Pa)	Water content (%)		Freezing time (min)	Freezing rate (cm/h)	Drying time (min)	
	Initial	Final			primary	secondary
24.0	81.8	4.0	52	4.4	1444	299
48.0	79.9	6.2	47	3.3	1302	411
76.0	78.8	2.5	63	3.3	965	436
74.6	80.1	2.8	70	2.7	1254	269
73.3	78.7	1.6	136	1.6	1299	181

Note: surface temperature was 23.4 °C

Table 2. Freeze-drying characteristics of ginger

Surface temperature θs (°C)	Chamber pressure (Pa)	Initial concentration Co (%)	Final water content (%)	Freezing time (min)	Freezing rate (cm/h)	Drying time (min)	
						primary	second.
20	36.89	9.3	2.35	274	1.10	1640	180
	36.95	11.9	2.38	256	1.32	1620	180
	36.68	14.8	2.47	237	1.02	1560	170
30	36.96	8.4	2.15	276	0.80	1670	166
	36.73	9.7	2.12	254	1.32	1570	170
	36.63	10.1	2.42	236	0.96	1540	180
40	36.84	9.4	2.30	267	1.45	1410	210
	36.47	16.5	2.06	266	1.45	1250	230
	36.58	16.7	2.24	224	1.41	1350	250

Quality of the Freeze-dried Javanese Piper and Ginger.

Table 3 and Table 4 show the quality assessment on the freeze dried Javanese piper and ginger, respectively. In general, quality of the freeze dried Javanese piper was better than those dried with oven dried at temperature 35-40 °C. Chamber pressure and freezing rate show no significant influence to the quality, which is quantified in ash content, solute in water, solute in alcohol, and piperin content.

Table 3. Quality assessment on the freeze-dried Javanese piper (*piper retrofractum*, Vahl)

Chamber pressure (Pa)	Freezing rate (cm/jam)	Ash content (%)	Ash and essense content (%)	Solute in water (%)	Solute in alcohol (%)	*Piperin content (%)*
24.0	4.4	4.51	0.04	20.13	19.22	3.33
48.0	3.3	4.32	0.11	20.12	19.85	3.14
76.0	3.3	4.93	0.03	20.54	17.17	3.18
74.6	2.7	4.53	0.03	20.52	15.28	3.41
73.3	1.6	4.81	0.32	22.60	20.48	3.45
Average		4.62	0.11	[illegible]	18.40	3.30
Oven drying (35°C-40°C)		4.26	0.10	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]		
	9.65	-	-	-	-
	10.11	-	-	-	-
40	9.4	5.11	0.51	12.89	22.16
	16.46	5.44	0.14	8.44	19.29
	16.65	-	-	-	-
Average		5.59	0.56	11.57	21.74
Before freeze dried		6.10	0.04	16.47	15.6
MMI Standard		**5.0 (max)**	**3.9 (max)**	**4.3 (min)**	**15.6 (min)**

The quality of freeze dried ginger was also found within the range of the MMI Standard, as shown in Table 4. Compared to the quality of the ginger before freeze dried, there was a slight decrease in the quality of the freeze dried ginger, except for the content of solute in water. The higher content of solute in water for the freeze dried ginger can be accounted to the hydro-diffusion nature of the solute, which could only leave the product if compounded in water. This is one of the advantages of freeze drying method, where water is freezed before sublimed at lower pressure. The freezing process could be used as a mean to separate water from the solute, while the sublimation is used to eliminate the water without converting it to liquid phase before to the gas phase. In this case, the solute can not leave the product for there was no liquid water to compound with. This is again confirmed by the higher solute content in water for the higher surface temperature, compared to the solute content in alcohol. However, the influence of surface temperature to the quality of the freeze dried ginger was not clear yet, even though there was a tendency of lower solute content in alcohol but higher solute content in water for the higher temperature.

CONCLUSIONS

1. Higher chamber pressure or faster freezing rate tends to shorten the primary drying time but lengthen the secondary drying time.
2. The quality of the freeze-dried product was slightly lower than the quality of the raw material, but there was a tendency of higher solute content in water, which is accounted for the hydro-diffusion nature of the solute.

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