



Effect of Inlet Air Temperature on the Properties of Spray Dried San-sakng (*Albertisia papuana* Becc.) Leaf

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ARTICLE INFO

Research Article

Received : 02/09/2019
Accepted : 14/05/2020

Keywords:

Spray drying
Free glutamic acid
Maltodextrin
Temperature
Umami

ABSTRACT

Free glutamic acid is a flavor enhancer compound that provided umami taste. San-sakng (*Albertisia papuana* Becc.) leaf has been used as a seasoning in the Dayaks tribe, West Kalimantan, Indonesia. The aim of this study was evaluated the effect of different drying inlet air temperature on physico-chemical of the spray dried san-sakng leaf. San-sakng leaf powders was produced using spray drying and maltodextrin as raw material. Completely randomized design was used with one factor, namely drying inlet air temperature on the spray drying process (130°C, 140°C, and 150°C). The results showed that moisture, solubility, bulk density, particle size, and encapsulation efficiency on the San-sakng leaf powders presented significantly affected by the drying inlet air temperature. Increasing inlet air temperature led to reduced moisture, bulk density, and particle size, whereas enhancing the solubility and encapsulation efficiency.

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Introduction

Flavourings are used as food additives for altering and enhancing the taste and/or aroma of food products. Reineccius (2005) explains that flavour enhancer is a substance that has no flavour (at level effects) but also intensifies or improve the taste of food. Zuhra (2006) argue that flavour enhancer as material that can improve the delicious taste or pressing of undesired taste. flavour enhancer substances that are obtained from plant or animal raw materials, by physical, microbiological or enzymatic processes are classified as natural flavouring substances. Flavour enhancer produces umami taste in foodstuff. Glutamic acid is a flavour enhancer compound that provides umami taste (Rangan and Barceloux, 2009). Among other amino acids that only free glutamic acid form as a flavour enhancer in the food industry (Populin et al., 2007). Free glutamic acid can be found in both plant and animal foodstuff. Vegetable foodstuff such as kombu, nori, tamarillio, tomato, macambo, garlic, potato, chinese cabbage, carrot, onion, and seafood such as scallop, shrimp, sea urchin, short necked clam, crab, egg yolk (Kurihara, 2009).

San-sakng (*Albertisia papuana* Becc.) leaf has been used as a flavour enhancer in the Dayaks tribe, West Kalimantan, Indonesia. Mayasari et al. (2015) reported that the san-sakng leaves extract identified free amino acid content of 40.44 mg/g dry weight. Mayasari et al. (2016) study emphasize that the addition of san-sakng leaf on local dishes such as vegetable is generally in fresh leaf. The lack of utilization of fresh leaves form is impractical and slightly shorter shelf life.

Encapsulation is the process of trapping a substance in another substance which is the ability to protect the bioactive component from destructive changes, transmute it into the form of flour, and protect its flavour (Zuidam and Shimoni, 2009; Shaikh et al., 2006; Estevinho et al. 2013). Spray drying is one of the useful techniques of the encapsulation process for changing liquids into solid powder form which is not only practice handling but also extends shelf life and improves the stability of food production. (Cai and Corke, 2000). During the encapsulation process, it is necessary to protect bioactive component with encapsulating product are appropriate,

encapsulate ratio, drying inlet and outlet temperature, and drying flow rate (Gharsallaoui et al., 2007; Yu et al., 2010).

Maltodextrin (MD) is a suitable wall material because it is more effective, bland in flavour, low viscosity at a high solid ratio and is available in a variety of molecular weights (Apintanapong and Noomhorm, 2003). Several studies confirm that MD potentials in preserving vitamin C in fruit juice and stability of acerola powder (Righetto and Netto, 2005). Several studies have been shown that the impact of drying inlet air temperature for the encapsulation process. 140-150°C inlet air temperature for encapsulation vanillin extract (Setyaningsih et al., 2007). 150°C inlet air temperature is the best treatment for pineapple powder (Suzihaque et al., 2015). Therefore, the aim of this study was to evaluate the effect of different drying inlet air temperature (130°C, 140°C, and 150°C) on physico-chemical of the spray dried san-sakng leaf.

Materials and Methods

Preparation of Raw Materials

The raw materials for the preparation of this study were san-sakng leaf, maltodextrin (MD) with Dextrose Equivalent (DE) 10.8%, and NaCl. San-sakng leaf was dried in a cabinet dryer at 50°C temperature until 10% moisture content. The leaf powder obtained from dried leaf was ground and sieved by 60 mesh sieve. The leaf powder was stored in the dark at a low temperature (-20°C) until used.

Water Soluble Extract Preparation

Water soluble extract (WSE) preparation was followed from Mayasari et al. (2016) in the previous study, the extract was obtained by infusion extraction method. 1 gram of leaf powder was diluted in 100 ml solution of boiling aquades at 90°C. The mixture solution was homogenized for 1 minute by vortex for 15 minute. The homogenized solution was vacuum filtered, then the residues were re-extracted with the same process as explained in the previous stage. The collected filtrate was added 0.6% NaCl, then homogenized for 1 minute by the vortex. Filtrate stored at freezing temperature (-20°C) until used.

Preparation of Encapsulation

MD was dissolved to distilled water with 1:1 ratio at room temperature. MD solution was added to san-sakng leaf extract, the total solid concentration (MD + extract) was set at 10%. This mixture was agitated using a magnetic stirrer at 200 rpm for 30 min at room temperature. The supernatant was vacuum filtered using Whatman No.2. It was heated in a waterbath at the temperature of 50°C. The subsequent homogenization process used the turrax (homogenizer ultra turrax T50) for 2,5 minutes at 4000 rpm. The homogeneous solution was filtered using a vacuum filter with Whatman filter paper no.41 (Ahn et al., 2008; Saloko et al., 2012).

Drying Condition

Drying condition was performed referring to Saloko et al. (2012). The homogenous solution was fed into a Buchi B-290 minute spray dryer (Flawii, Switzerland) for drying. The operating conditions were as follows; aspirator rate 50%; drying inlet air temperature 130°C, 140°C, and 150°C, while the outlet air temperature varied between

82°C; feed flow rate was set at 5.1 ml/minute; atomization air rotameter 30 mm and the nozzle cleaner set to 4. Spray-dried powders kept in vacuum sealer polyethylene and stored at room temperature.

Moisture Content

The moisture content of powder determined following to the AOAC (2008) methods. The sample was measured by a hot air oven at 105°C for constant weight.

Solubility

The solubility described according to the Eastman and Moore method (Cano et al., 2005) with some modification by Avila et al. (2015). The san-sakng powder (1 g) was homogenized in 50 mL distilled water in a vortex for 30 seconds. The san-sakng solution centrifuged at 3,000 rpm for 5 min at 25°C. A 25 mL aliquot of the supernatant was placed to Petri dishes. Then, drying in an oven at 105°C for 5 h. The solubility spray dried san-sakng leaf was calculated as the initial weight minus the final weight divided by the initial weight.

Morphological Examination

The morphology of spray dried product was determined by a scanning electron microscope (SEM FEI, Inspect S50, Oregon, USA). The morphology was used to study the surface characteristic of the powder. The powder was coated with gold and measured at 10,000 magnifications.

Bulk Density

Bulk density was determined by weighing ± 1 gram of powder, then it is transferred to 50 mL graduated cylinder. Packed bulk density was recorded after rapped gently the cylinder by hand for 50 times from a height of 10 cm (Goula and Adamopoulos, 2004).

Particle Size Distribution

The product spray dried was measured according to Carneiro et al. (2013) method that particle size distribution of sizes formed using a laser particle size distribution analyzer (Malvern Zetasizer Nanoseries Nano ZS Ver 6.20, Malvern Instruments Ltd, Malvern, UK). The particle size distribution was expressed until successive readings became constant.

Encapsulation Efficiency

Encapsulation efficiency (EE) was expressed by free glutamic acid content. Determination of free glutamic acid content was established following to modification from Purwayantie et al. (2015) methods. 100 mg of powder were dissolved in 10 ml aquades, then vacuum filtered. 4 ml from supernatant centrifuged for 2 min. 25 μ l of supernatant were mixed with 300 μ l of OPA (o-Phthaldialdehyde) solution, vortexed for 1 min. 20 μ l aliquot was injected and analysed using HPLC (SHIMADZU LC 10) with a Licrospher 100 RP 18 (5 μ m) and a 125 \times 4 mm column. The separation of OPA-derivatives was performed using a mobile phase consisting of methanol, 50mM Na-acetate, THF (2:9:2) at pH 6.8 as solvent A and 65% methanol as solvent B. The gradient elution program was held at 100% of A for 0.1 min, ramped at 100% of B for 45 min and stopped at 50 minutes with a flow rate of 1 ml/min. Detection was set at 360nm (Ex) and 460nm (Em). Free glutamic acid was measured by

using the authentic standard (Sigma-Aldrich) and quantified by the calibration curve of the external standard.

Statistical Analysis

All data resulted were analysed based on Completely Randomized Design at a confidence level of 95%. Significances of averages were calculated with a DMRT using SPSS version 15.0 software. All data were performed in triplicates.

Results and Discussion

Moisture Content

The moisture content affects the quality of the food product. Table 1 showed that the percentage of moisture content of san-sakng powder varied between 0.70 to 1.01%. Analysis of variance showed significant differences ($P<0.05$), that increase inlet air temperature will decrease moisture content. This is due to Phisut (2012) explains that the higher inlet air temperature gives the greatest driving force for water evaporation. Hence it, the moisture content will decrease by increase the drying inlet air temperature.

Solubility

Table 1 showed that the percentage of solubility of san-sakng powder varied between 97.98 to 98.10%. Analysis of variance showed significant differences ($P<0.05$), that increase inlet air temperature will increase solubility. The maltodextrin was a carrier exhibited good solubility and added no flavour or odour to the final product (Kenyon, 1995; Wang and Wang, 2000). Ersus and Yurdagel (2007) states that maltodextrin given a high values of solubility in water. Solubility is directly related to the microstructure of the powder. A larger amorphous surface means that the powder will have more solubility in water (Cano et al., 2005).

Particle Size Distribution

The particle size of san-sakng powders was 43.14 to 101.71 nm (Table 1). Analysis of variance showed

significant differences ($P<0.05$), that the higher temperature decreases the particle size. This result is due to Chegini and Ghobadian (2005) states that increasing inlet air temperature gives a rapid formation on the droplet surface. Therefore, particle size change beside the skinning over or case hardening on the droplets at the higher temperature. It leads to the formation of favour-impermeable films on the droplet surface followed by the formation of vapour bubbles and the droplet expansion.

SEM of Spray Dried San-sakng Leaf

A representative scanning electron microscopy (SEM) of the spray dried san-sakng powder determined at magnification 10000x in Figure 1. The features showed that the all the samples using inlet air temperature 130°C, 140°C, and 150°C presented spherical particles with wrinkled surfaces. These similar features have been found in spray-dried coconut shell liquid smoke powder (Saloko et al., 2012). This phenomenon was suggested that under processing method. Chin et al. (2010) states that particles with wrinkled surfaces resulted in spray drying are caused by particle shrinkage during the process drying. Patel et al. (2009) argue that spherical particles have a large surface or volume ratio that suitable for spray drying products.

Encapsulation Efficiency

Free glutamic acid is the taste-active compound found in natural sources (Ninomiya, 1998). The free glutamic acid compound developed flavour enhancer was analysed by HPLC. According to the result in Figure 2, free glutamic acid was identified in the WSE san-sakng leaf and spray dried powders at different drying inlet air temperature by comparing peak retention time with amino acid standard. The encapsulation efficiency of glutamic acid varied between 94.49 to 96.85% (Table 1). Analysis of variance showed significant differences ($P<0.05$). The optimum condition of inlet air temperature was achieved at temperature 140°C that produced the highest encapsulation efficiency was 96.85%. In relation to the SEM of particle features that spherical features can retain the highest amount of flavouring agents (Reineccius, 2004).

Table 1. Characterization of Spray Dried San-sakng Leaf at Different Inlet Air Temperature (130°C, 140°C, and 150°C)

Inlet Temperature (°C)	Response Variables				
	Moisture (%)	Solubility (%)	Bulk Density (g/mL)	Particle Size (nm)	Encapsulation Efficiency (%)
130	1.01±0.03 ^c	97.98±0.05 ^a	0.53±0.02 ^c	101.71±0.11 ^c	94.49±0.08 ^a
140	0.87±0.01 ^b	98.08±0.03 ^b	0.46±0.34 ^{ab}	73.99±0.54 ^b	96.85±0.07 ^c
150	0.70±0.01 ^a	98.10±0.03 ^c	0.46±0.03 ^a	43.14±0.87 ^a	95.33±0.01 ^b

^{a,b,c} The different letters in the same line represent that there are significant differences at the level of $P<0.05$, and the same letters represent no significant difference

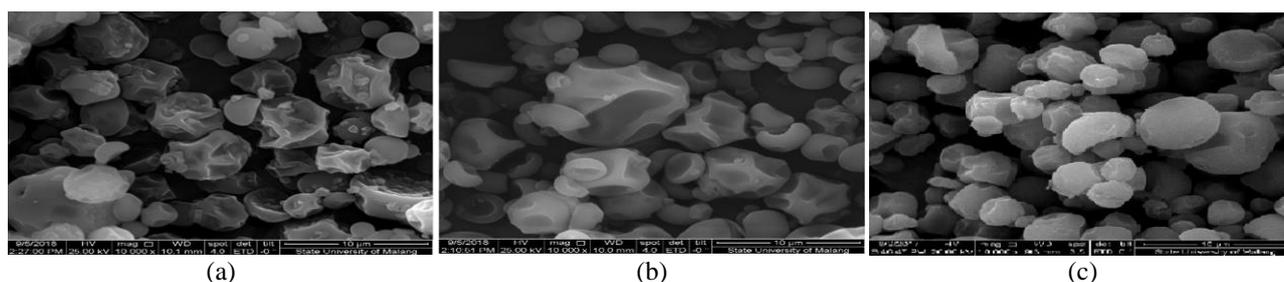


Figure 1. Scanning Electron Microscopy (SEM) Images of Spray Dried San-sakng Leaf at 10.000 x magnification at Different Inlet air Temperature (a)130°C, (b)140°C, (c)150°C

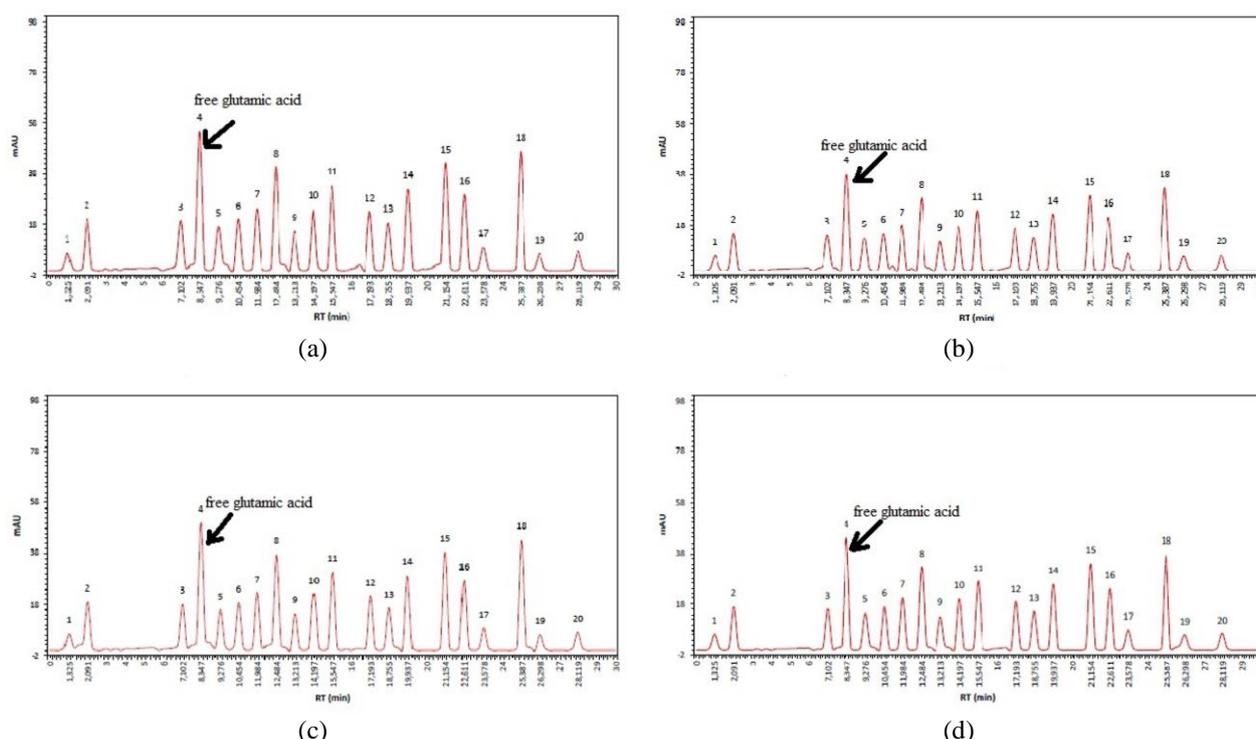


Figure 2. Free Glutamic Acid Content of Spray Dried San-sakng Leaf at Different Inlet Air Temperature; (a)WSE san-sakng leaf; (b)130°C; (c)140°C; (d)150°C

Bulk Density

The values of bulk density were in the range of 0.46-0.53 g/mL (Table 1). Analysis of variance showed the inlet air temperature have a significance difference ($P < 0.05$), that increase inlet air temperature will decrease bulk density of spray dried san-sakng leaf. These similar results have been found in grape syrup powder obtained by spray drying (Sarabandi et al., 2014). According to Walton (2000) increasing the drying air temperature generally produces a decrease in bulk and particle density.

Conclusion

The results of this study confirm that different drying inlet air temperature impacted to the san-sakng extract powder quality. As a conclusion the different inlet air temperature in drying process influences the moisture, solubility, bulk density, particle size, and encapsulation efficiency. The higher drying inlet air temperature decreases moisture, bulk density, and particle size, whereas the solubility and encapsulation efficiency is increased.

Acknowledgments

We sincerely acknowledge for The Ministry of Research, Technology and Higher Education of Indonesia was provided this research funding.

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