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Low Temperature Seaweed Drying Using Dehumidified Air

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Abstract

The seaweeds are the important commodities as raw material for food or additives. One of the popular seaweeds, *Eucheuma cottonii*, contains carrageenan for starch or fiber sources that can be applied for beverages or gelatin. Currently, the seaweed has been widely provided as dry product in order to minimize the cost for transportation as well as prolong storage life. However, current drying process still deals with energy in-efficiency and product quality degradation. The dehumidified air can be an option to retain the seaweed quality. With lower humidity, the driving force for drying can be improved in which shortened drying time. This research aimed to study the effect of air temperature, humidity, and velocity on seaweed drying. For supporting the study, the several drying kinetic models were developed to predict drying rate. Furthermore, the seaweed quality was evaluated based on rehydration ratio. Results showed that for all cases, drying at 70^{o}C or below can provide reasonable drying time. The higher air temperature and air flow, the faster drying time. Meanwhile, the dehumidified air also affected drying time positively. In addition, the model based on Page is the best option to estimate the drying rate. For all drying condition, the rehydration ratio of dry seaweed was close to the initial wet condition. This implied that the dry seaweed was very suitable for food.

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Keywords: Euchema cottonii; humidity, kinetic, seaweed

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Nomenclature

X	the moisture content in product
X_e	the equilibrium moisture
X_0	initial moisture content
MR	Moisture ratio
B	the constant of sorption
D	the constant of sorption
a_w	water activity
K	the constant of sorption
L	the material thickness
D_{eff}	Effective diffusivity
t	sampling time
k	constant of drying
μ_k	kinematic viscosity

1. Introduction

The seaweed is the important product in food as natural fiber resources. It has been also used as raw material for food additive such carrageenan, alginate, and agar. Harvested seaweed containing about 90% water required to be dried before distributing to the markets or consumers. Currently, two types of seaweed drying have been applied, namely direct sunlight dryer and conventional convective dryer. The direct sunlight dryer was very simple and cheap. However, the dry product quality and process continuity depend on climate or weather. Moreover, by placing in the opened area, the dry seaweed product was not hygiene[1,2]. The conventional convective dryer was more convenience for flexibility drying condition and ensure the process continuity. However, the cost for energy and nutrition degradation due to the heat introduction, became the main problems[1,2].

Refer to material and equipment, the several seaweed dryers have been studied. Tello-Ireland et al., (2011) studied the effect of hot air drying on *Gracilaria chilensis*[3]. The result showed the higher temperature reduced the seaweed re-hydration and antioxidant activity. It mean that the higher temperature was not recommended. Gupta et al., (2011), stated that drying kinetic of seaweed can be predicted[4]. The moisture diffusion depend on temperature following Arrhenius relationship[4]. They also found that phytochemicals substance decreased during the drying process.

Fudholi et al., (2011) studied the effects of air temperature and humidity on the drying time and kinetics of seaweed[5]. The research concluded that higher temperature, faster drying rate. Several models were also validated to express the drying curve where the Page model can represent the drying curve precisely. The research was continued to design seaweed drying by solar dryer[6]. Results also showed that the Page model was still valid. The drying time was about 7 hours to dry seaweed from 94.60% up to 8.33%. Mohamed et al., (2007) has investigated the effect of air temperature and flow on the drying kinetic of *Gelidium sesquipedale*[7]. Two term models were formulated in which showed the good model prediction.

The seaweed contains heat sensitive material such as protein, and starch. The operational temperature and drying time are key factor to retain seaweed quality. Higher temperature can speed up drying time [1]. However, the nutrition such as protein will deteriorate. Meanwhile, too long drying time also increased the total of nutrition degradation. Based on the above references, the predicted drying time at several operational temperature was still the important issue. Hence, the drying process can be shorter and the product quality can be higher.

Adsorption dryer with zeolite can be an option for seaweed drying. In this case, the air as drying medium was contacted with zeolite to remove the water content (air dehumidification). With low relative humidity, the driving force for drying can be enhanced [8,9]. So, the seaweed drying can be well conducted in low temperature and the product quality can be retained.

This paper discusses the drying time for seaweed at various temperature, air flow, and humidity. In doing so, several standard kinetic models for drying were also validated using experiment result. As indicators, the drying time was estimated, and product quality in term of rehydration capacity was observed.