Ion wind generation and its application to drying of wild Ginger slices (Curcuma Xanthorhiza)

by Sumariyah Sumariyah

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Ion wind generation and its application to drying of wild Ginger slices (*Curcuma Xanthorhiza*)

Sumariyah[a*], Ainie Khuriati[a], Enny Fachriyah[b]

[a] Physics Department, Mathematics and Sciences Faculty, Diponegoro University,Indonesia
[b]Chemistry Department, Mathematics and Sciences Faculty, Diponegoro University, Indonesia

E-mail: sumariyah.jaelani@gmail.com

Abstract. Temulawak or wild ginger is a herbal medicinal derived fromIndonesia original. Wild ginger contains include anactive compound ascurcuminoid and antioxidant oleoresin components having a special quality to take care of health from various diseases. Drying is the important process to produce wild ginger (Curcuma xanthorrhiza) simplicia as raw material herbal medicine. In this study, has been dried of wild ginger using ion wind which yielded from corona discharge utilizing pin-multi ring concentred electrodes. Corona discharge was generated by using the fixed DC high voltage of 4,3 kV and drying was done at the distance between the fixed electrodes of 4 mm. Shaped of the five temulawak slices is a circle with a thickness of 2 mm and the diameter of 10 mm - 30 mm with 5 mm diameter interval. The sliced temulawak is placed just below the concentric multi-ring electrode and is 2 mm in distance. The wild ginger slices were dried with time varied 5-65 minutes with time interval 5 minutes. The researched result of drying of wild ginger slicesobtained drying rate and shrinkage is inversely proportional to drying time.

Keywords: Ion wind, corona discharge, wild ginger, drying rate, shrinkage.

1. Introduction

An ionic wind or also called an electrohydrodynamics (EHD) flow produced by a corona discharge is a stream coming from an ionized air generated by a strong electric field. The research that supports the existence of ion wind is done by several researchers, among others: research on the existence of ion wind, maximum ion wind flow angle and ionic wind sweep [1] which is the result of analysis of electrohydrodynamic phenomena on the surface of silicone oil using corona discharge positive with pin-plate electrode. And a study of the characteristics of thevelocity of an ionic wind yielded fromcorona discharges using the electrode configuration of apin-multi ring concentric [2]. The results of the research showed thatthere was an increase in the velocity of the ionic wind yield from the corona discharge utilizing pin-multi ring concentred electrode rather than using pin-ring electrode.

In this study, ion wind was applied to dry the simplicia of Temulawak or wild ginger (Curcuma xanthorhiza). Temulawak is a medicinal plant derived from Indonesia. Temulawak contains anactive compound of acurcuminoid and some essential oils components having aspecial quality to take care of health from various disease. [3]. Curcuminoid having special quality as anantioxidant [4]. The ginger rhizome is used by the medical industry in fresh form and/or in the form of simplicity. Dry storage of simplicity is needed to overcome constraint power supply during harvest season.

Drying is one way of physical preservation of the sample. Various methods of drying samples include drying with Solar Dryer, drying and freeze-drying ovens [5], a microwave vacuum dryer [6]. Conventional drying of wild ginger under the sun depends on weather and potentially to contaminated by pollutant. Meanwhile, the electric power used for drying the wild ginger by using an oven or microwave is large. As one of the most widely used processes, drying operations in the food and drug industries require 15-20% of the total energy demand [7]. Therefore in this research used drying system with low power usage that is drying system using the ion wind yielded from the corona discharges. The application of ionic wind as drying has been done [8,9,10,11,12]. Drying of samples using ion winds has many advantages that besides the use of low power, the generator also does not require moving parts, free from mechanical and acoustic vibration noise, and deadly of microbes that exist in the ginger slice due to corona discharge system in addition to producing ionic wind as well as ozone.

2. Method

Temulawak or Wild ginger (Curcuma xanthorhiza) before the cut, temulawak peeled and then cut into slices with a circular shape with 3 mm thickness and diameter varied from 1-3 mm with 0.5 mm the interval variation.

The ion wind is generated through positive corona discharges with the electrode configuration of the pin-multi ring concentred. The pin electrode has a pointed tip diameter of 0.026 mm. Concentric multi-ring electrodes consist of 3 the concentric rings electrodes. they have the same width and thickness of 2 mm each and 8 mm, 16mm and 24 mm diameter respectively. The series of experiments in this study is shown in Fig.1.

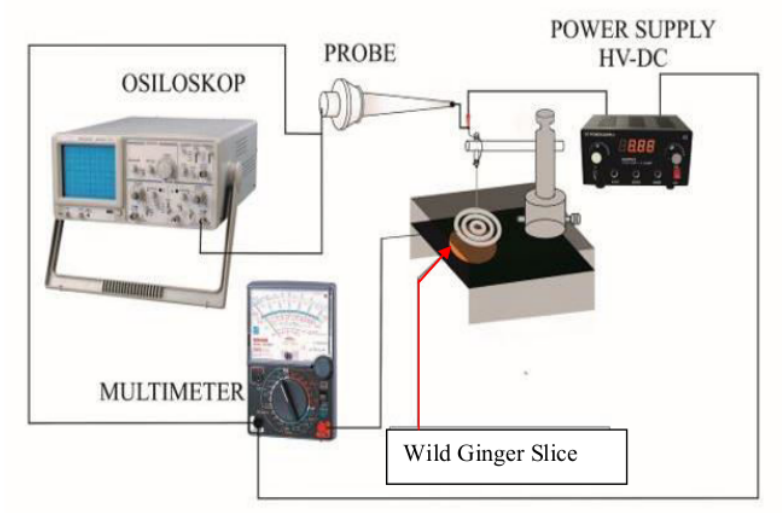

Fig.1. Experimental circuit with ion wind

The generating of corona discharge to produce the ion wind is performed at the distance between the 4 mm electrodes and the DC high voltage of 3.4 kV. The voltage measurements are given to the corona discharge generating system through the high voltage probe voltage divider (SEW high voltage probe P20 P28) and the installed voltage can be determined using an oscilloscope (Good Will instrument, code number 5694495, Malaysia). In the case of the corona discharges, one of the radiations from the discharge is an ionic wind will flow from the pin electrode to a multi-ring concentric electrode which will dry the ginger slices located under a multi-ring concentric electrode at

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a distance of 2 mm from the center of the electrode. Each temulawakslices was dried at the distance between the electrode and fixed voltage with avariation of time 0-25 minutes with atime interval of 5 minutes.

3. Result and discussion

3.1. I-V characteristics and I-u characteristics

Thecharacteristics of the current (**I**) is function of the voltage (**V**) at the distance between the electrodes d = 4 mm in the form of the **I-V** characteristics of the ionic wind generator in black and the characteristic of the ionic wind rate (**u**) as a function of voltage (**V**) are the **u-V** characteristic with red color as shown in Fig. 2.

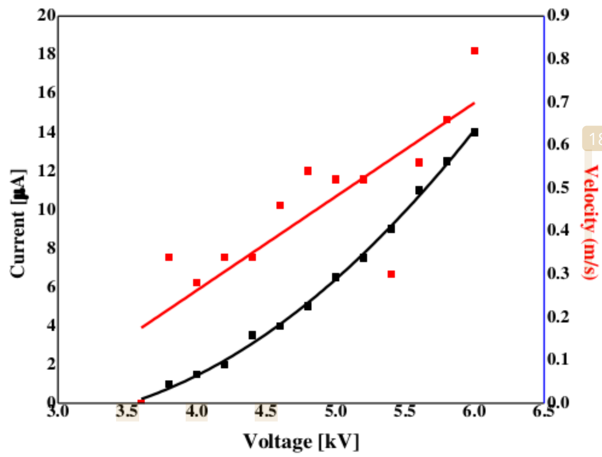

Fig.2. I-V characteristics and I-u characteristics

In Fig.2.it shows that at the distance between electrodes (**d**) fixed, the greater the applied voltage the greater the resulting current. The current value of current proportional to the square of the value of voltage **V** (**I** ∞ **V**^{2}) in accordance with this in accordance with the results of the Sumariyah experiment (2015). At the distance between electrodes (d) fixed, the greater the voltage given the greater the wind speed the resulting ion. This is because the relationship between the voltage and wind speed of the ion is a linear function. In accordance with the results of the Sumariyah experiment (2016) which shows that **u** ∞**V.** Temulawak slices were dried at a distance between 4 mm electrodes and a voltage of 4.3 kV and from Fig.2. Obtained a current of 2 μA and a velocity of ion wind of 0.33 m / s.

3.2. Drying Rate

The graph of the relation between drying rate (DR) of temulawak slices as a function of time (t) of drying at the diameter of a constant ginger slice and at the distance between the electrodes d = 4 mm and a voltage of 4.3 kV as shown in Fig. 3

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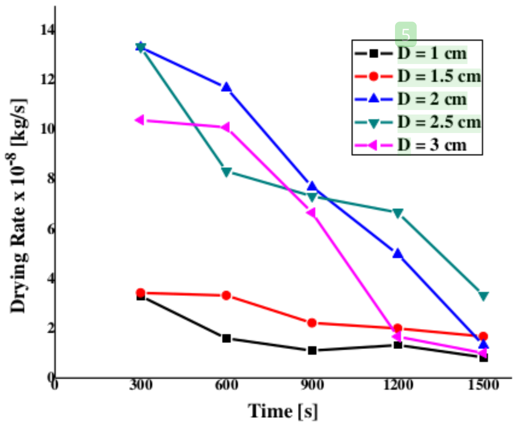

Fig.3. Drying rate of Temulawak slices vs. time

In Fig.3.it shows that it appears that the drying rate of Temulawak slices is inversely proportional to the drying time. This is in accordance with the formula in Srinivasan's research paper (2017). This happens because during the drying process there are two processes of moving heat and mass. Heat is needed to evaporate the water contained in the material. Evaporation occurs because the material temperature is lower than the surrounding air temperature. The temperature difference causes the transfer of heat from the dryer chamber to the material so that the vapor pressure in the material is greater than the vapor pressure inside the material. This causes the water contained in the material to evaporate into the air, resulting in themass transfer of moisture from material to air. This resulted in the concentration of water in the slices of ginger is increasingly reduced. This will result in a decrease in the vapor pressure. because the difference in pressure difference decreases the evaporation of water in the material will also decrease. This will cause the drying rate the longer the drying time decreases.

3.3. *Efficiency*

The energy efficiency (η) of drying is calculated from the amount of energy required for water evaporation by kJ / kg unit. Graph of energy efficiency function of sample diameter at time 600 second on the sample with D = 1,1,5,2, 2.5 and 3 cm and a thickness of 2 cm at a voltage 4.3 kV and a distance of 0.6 cm electrodes as shown in Figure 4. In Figure 4. Shows the efficiency decreases as the sample diameter increases. This is due to the larger the diameter the greater the drying rate.This is due to the larger diameter the greater the drying rate so that the energy efficiency is inversely proportional to the drying rate.

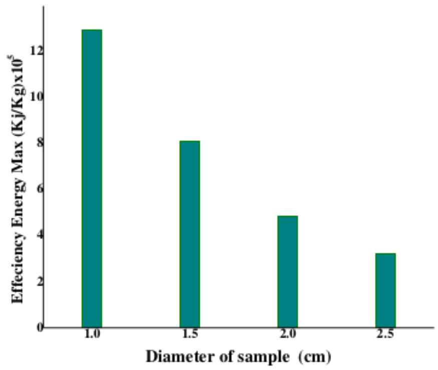

Fig. 4. Efficiency of Temulawak Drying

3.4. Shrinkage

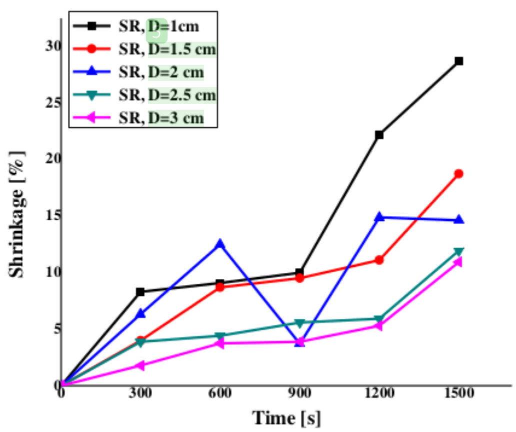

Fig.5. Shrinkage of the temulawakdrying

Shrinkage (SR) of temulawak slices during drying cannot be avoided because of the heating process and the discharge of water from the material. When water comes out of the material there is an imbalance between the pressure inside the material and outside the contraction material and triggers shrinkage, deformation and sometimes breaking or cracking of materials. The graph of shrinkage (%) of temulawak slices function of time [s] drying the sample with diameter $D = =$ 1 cm,1.5 cm, 2 cm, 2.5 cm and 3 cm and a thickness of 2 cm at a voltage V =4.3 kV and a distance d =6 mm electrodes as in Fig.5. It shrinkage of temulawak slices increases with increasing drying time. This is due to the longer drying time, the more water coming out of the sample. The shrinkage on the drying of temulawak slices with D = 3 cm was smallest. It due to on the ginger slice with D = 3 cm on the outer circumference of the slicesno exposure to EHD flow.

4. Conclusion

The current value ofcurrent**I**am proportional to the square of the value of voltage **V** ($\mathbf{I} \propto \mathbf{V}^2$). At the distance between electrodes (d) fixed, the greater the voltage given the greater the wind speed the resulting ion. Drying of temulawak slices at the distance between electrodes remained $d = 4$ mmand voltage $V = 4.3$ kV resulted the drying rate for all samples decreased with increased time. Drying rate for the constan time will increase as the diameter temulawak slices increases. The energy efficiency for the constan drying time will decrease as the diameter of temulawak slices increases. Shrinkage of sample will increase with increasing drying time.

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