C13_Ion wind from yield corona discharge and its application to drying of Turmeric slices (Curcuma domestica Val)

by Ainie Khuriati

Submission date: 18-May-2023 12:44PM (UTC+0700)
Submission ID: 2096019893
File name: C13_Ion_wind_from_yield_corona_discharge_and_its.pdf (806.98K)
Word count: 2373
Character count: 11475

IOP Conf. Series: Journal of Physics: Conf. Series **1170** (2019) 012026 doi:10.1088/1742-6596/1170/1/012026

Ion wind from yield corona discharge and its application to drying of Turmeric slices (*Curcuma domestica Val*)

Sumariyah[1,*], A Khuriati[1], S H Pratiwi[1] and E Fachriyah[2]

[1]Physics Department, Diponegoro University, Semarang, Indonesia
[2]Chemistry Department, Diponegoro University, Semarang, Indonesia

*Corresponding author: sumariyah.jaelani@gmail.com

Abstract. Turmeric (*Curcuma domestica Val*) is a native Indonesian medicinal plant. Drying sliced turmeric is an important process to get the basic herbal ingredient of a durable herb. The purpose of this study was to apply the ion wind of corona discharge to dry the turmeric slices and its characterization.The corona discharge is generated by using a pin-three of ring electrode which is subjected to a high voltage DC with positive pin electrode polarity and a negative concentric three-ring electrode. The ion will flow from the pin electrode to the three-ring electrode and a portion will be forwarded through the gap between three concentric rings. The drying of the turmeric slices is carried out at distance between electrodes which is constant. It is placed just below the concentric three-ring electrode and the distance between electrode is 2 mm. The drying of turmeric slices is time-varying 5 to 65 minutes with a time interval of 5 minutes. The study result of drying of turmeric slices is obtained drying rate and mass shrinkage is inversely proportional to a drying time. While the efficiency of drying is inversely proportional to the drying rate.

1. Introduction

The drying process is one of the many processes in the chemical industry, the food industry, and the pharmaceutical industry. Especially in the herbal medicine industry such as for drying simplicia and dried rhizomes. The sample drying process can take advantage of direct solar, wind, oven, or microwave heat. Example of solar drying of the agricultural product [1] and drying of wind-driven rain on a window glass surface [2]. While research on the effect of sun, oven and microwave drying on quality of onion slices [3]. As one of the widely used process, in several developed countries have reported that drying operation in the industry require energy between 12 and 20 % of the total energy needs [4]. Therefore, that the development of the drying process is increasingly directed to the discovery of the drying method by increasing energy efficiency.

In this research has been applied dryer system that consumes low enough energy that is drying system of ion wind from yield corona discharge to dry the turmeric slices (*Curcuma domestica Val*). It is one of the most useful herbal medicinal plant belonging to the Zingiberaceae family originating from Southeast Asia spread to Malaysia, Indonesia, Australia, and Africa. The main compound contained in the turmeric rhizome is the compound curcuminoid. The curcuminoid compound gives the yellow color to turmeric. The use of turmeric for various diseases such as cancer, diabetes mellitus and inflammatory disorder [5]. The purpose of this study was to apply the ion wind of corona discharge to dry the turmeric slices and its characterization.

IOP Conf. Series: Journal of Physics: Conf. Series **1170** (2019) 012026 doi:10.1088/1742-6596/1170/1/012026

Ion wind or corona wind is a stream coming from the ionized fluid generated by a strong electric field. The ion wind produced by the electrode is charged with direct current (positive or negative) at a sufficiently high voltage (in the kV range). While the applied voltage can be high, the involved currents are usually very small (in the mA range), which makes the required power low enough [6]. Another advantage of an ion wind drying system is that it can eliminate environmental microorganisms during the drying process [7]. Instruments using ion wind from yield corona discharge also have many advantages including its instruments do not require moving parts and provide flexibility in the form of channels and are free of mechanical and acoustic vibration noise and can be operated at atmospheric pressure and room temperature [8].

2. Materials and Methods

2.1. Procedure

Drying rate (DR) of turmeric (*Curcuma domestica Val*) slices was calculated using Eq. (1) and expressed as kg of water/kg dry matter. min

$$DR = \frac{m_1 - m_2}{t_2 - t_1} \quad (1)$$

where $t_1$and t_2 are two different times (min) during drying; m_1 and m_2 are the mass (kg water/kg dry matter) of the ginger slices at time t_1 and t_2, respectively [9].

Energy efficiency (η) was determined from the supplied electric power (kW) and the drying rate (kg/s). It was calculated using Eq. (2) [10].

$$\eta = \frac{VI}{\Delta m}\Delta t \quad (2)$$

Where voltage, current I, and Δm was determined from the balance as a mass reduction for the time Δt [11].

The mass shrinkage of turmeric (*Curcuma domestica Val*) was calculated using the equation

$$S = \frac{m_1 - m_2}{m_1} \times 100 \quad (3)$$

Where S is the shrinkage of the turmeric slices (%), m_1 is the mass of the blanched turmeric slices before drying (kg), $m_2$is the final mass of the turmeric slices at the end of drying (kg) [12].

2.2. Sample preparation

Turmeric (*Curcuma domestica Val*) is purchased from traditional markets in Semarang, Indonesia, and kept below room temperature. The initial moisture content of turmeric samples ranged from 21.4%. Before the cut, turmeric is peeled and then cut into a circular slice with a thickness of 2 mm and a diameter varied from 1-3 mm with a variation interval of 0.5 mm.

The main components of the corona discharge generator which yields ionic wind consist of pin electrodes, and concentric three-ring electrodes. Pin electrode is made of stainless steel sewing needle material with a pointed tip diameter of 0.14 mm. Concentric three-ring electrodes consist of 3 Concentric Rings electrodes. The third of rings electrode have the same width and thickness is 2 mm and it has diameters 8 mm, 16 mm and 24 mm diameter respectively.

The corona discharge is generated at the distance electrode is between the 6 mm and the DC high voltage applied of 3.4 kV. The voltage measurements which are given to the corona discharge generating system through the probe of high voltage and the installed voltage can be determined using an oscilloscope. The electric current after discharge was measured using a multimeter (Sanwa electronic instrument CD772 made by Tokyo).

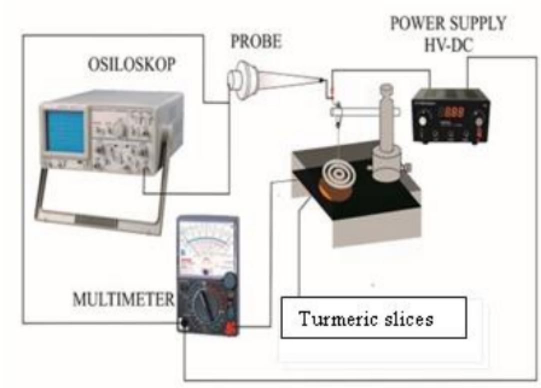


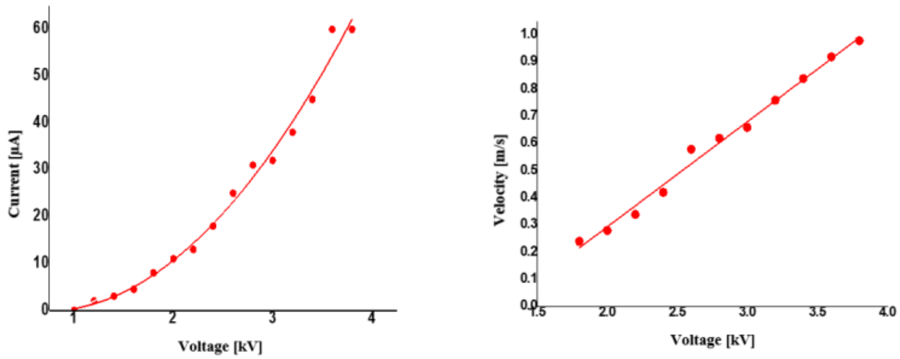
Figure 1. The circuit of ion wind drying

In the case of corona discharges, one of the radiations from the discharge is ionic wind will flow from the pin electrode to the concentric three-ring electrode which will dry the sample which is beneath the concentric three-ring electrodes. The distance of the sample with the concentric three-ring electrode is 2 mm. The circuit of ion wind drying is shown in Figure1

3. Results and Discussion

3.1. Characteristic of the Dryer System-Ionic Wind

The characterization results of the Corona discharge generator which produce an ion wind is a graph of current as a function of voltage and graph of the velocity of the ion wind as a function of the voltage on the radius of the pin electrode rand on the distance between electrodes *V* constant as shown in Figure.2



(a) **(b)**

Figure 2. (a) *I-V* characteristics and **u**-*V* characteristics of the ion-wind dryer system

In Figure 2 (a) it appears that the greater the applied voltage the greater the resulting current. This is consistent with the experimental results by Nur [13] and Sumariyah [14-16]. The current value (I) is proportional to the square of the value (V) (I ∞ V2). In tandem with the added voltage applied to the EHD flow generator, the measured current is increased. In Figure 2 (b) it is seen that the greater the applied voltage the resulting velocity of the ion wind rate is greater. This is because the

IOP Conf. Series: Journal of Physics: Conf. Series **1170** (2019) 012026 doi:10.1088/1742-6596/1170/1/012026

relationship between voltage and velocity of ion wind is a linear function. In accordance with the theoretical formulation which shows that u∞ V. This is due to the greater the voltage, the electric field generated greater so that the ion generated due to the process of ionization of air by the electric field more and more resulting in greater ionized air ion is increased.

3.2. *Drying rate*

The drying of sliced turmeric (*Curcuma Domestica*) with an ionic wind generated at a constant voltage V = 4.0 kV and at a distance between fixed electrodes is d = 6 mm totaling 5 pieces. The graph of the drying rate sample (kg / s) as a function of the drying time (s) as shown in Figure.3. In Figure.3 it is shown that the drying rate for all the turmeric slicing diameters is decreased with the longer the drying time. This is accordance with the experimental results of the electrohydrodynamic drying of the Chinese wolfberry fruits by Maosheng *et al* [16] and the electrohydrodynamic drying of the carrots slices [17]. This is due to the longer time result the water content in the sample after being dried will be less and the drying rate decreased.

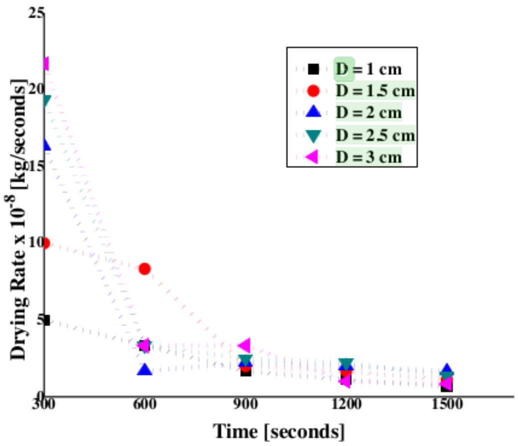


Figure 3. The drying rate for all the turmeric slicing diameters

3.3. *Energy 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 seconds on the sample with diameter D = 1;1,5; 2; 2.5 and 3 cm and a thickness of 2 cm at a voltage 4.3 kV and a between the distance of electrodes 0.6 cm as shown in Figure 4.

IOP Conf. Series: Journal of Physics: Conf. Series **1170** (2019) 012026 doi:10.1088/1742-6596/1170/1/012026

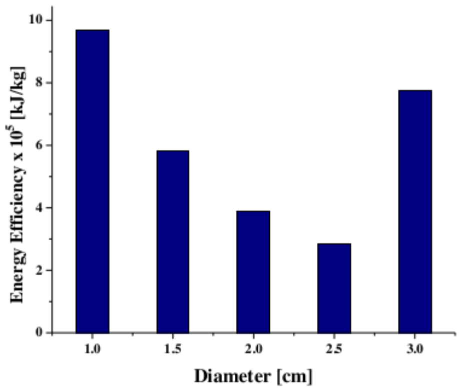


Figure 4. Graph of energy efficiency function of the sample diameter

Figure 4 shows the energy efficiency decreases as the sample diameter increases. This is due to the larger the diameter the greater the drying rate. While energy efficiency is inversely proportional to drying rate. This is in accordance with the equation 2.

3.4. Mass shrinkage

The graph of mass shrinkage of the function drying time function at a voltage of 4.3 kV and the distance between electrodes 0.6 cm as shown in Figure. 5.

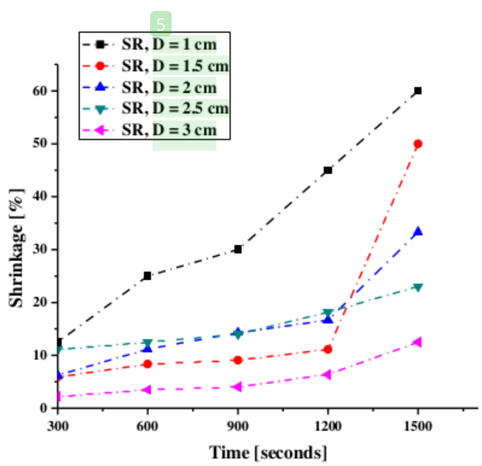


Figure 5. The graph of shrinkage mass as the function of the drying rate of turmeric slices

Figure 5 shows that the shrinkage of mass decreases as the sample drying time increases. This is because at the beginning of the drying time a large amount of evaporation has occurred which causes subsequent shrinkage to be smaller. At the same drying time, the mass shrinkage enlarges with an increase in diameter of the sample. This is due to the great diameter, the evaporation water of the sample more. This is the energy efficiency is inversely proportional to the drying rate.

4. Conclusion

The characterization of the drying system with wind ions from the corona release in the form of graphs of ion currents and ionic wind velocity as a function of the voltage, the ion current, and ion wind velocity will increase with increasing voltage added. Drying sliced turmeric produces the greatest dryness for all diameters at 300 seconds after drying. The longer the drying time the drying rate decreases. The mass shrinkage for all samples is inversely proportional to the drying time. While the drying energy efficiency is inversely proportional to the drying rate.

References

[1] Sebaii A A and Shalaby S M 2012 *Renew. Sustain. Ener. Rev.* **16** 37
[2] Blocken B and Carmeliet B 2015 *Build. and Envir.* **84** 170
[3] Arslan D and Mehmet M O 2010 *LWT - Food Sci. Technol.* **43** 1121
[4] Bardy E, Merouane H Michel H and Olivier R2015 *Energy* **89** 519
[5] Nasri H, Najmeh S, Mortaza R, Samira R, Maryam S and Mahmoud R 2014 J *Herb. Med. Pharmacol* **3** 5
[6] Esehaghbeygi A and Basiry M 2011 *J. of Food Eng.* **104** 628
[7] Zhang J I and Lai F C 2011 *J. Electrostatics* **69** 486
[8] Law C L 2014 *Encycl. Food Safe* **3** 156
[9] Dinani S T and Havet M 2015 *J. Clean. Prod.* **95** 203
[10] Timothy I J G, Peter W G and Sylvia M G 2007 *J. of Food Eng.* **80** 1233
[11] Martynenko, Alex., and Tadeusz Kudra, 2016 *Japan J. of Food Eng.* **17** 123
[12] Li F, Li L, Sun J and Tatsumi E *2005 J. of Food Eng.* **77** 275
[13] Nur M, Azzulkha A H, Restiwijaya M, Muchlisin Z and Sumariyah 2014 *Adv. Phys. Theor. Appl.* **30** 55
[14] Sumariyah S, Kusminarto K, Hermanto A and Nuswantoro P 2015 *Appl. Mech. Mater.* **771** 227
[15] Sumariyah S, Kusminarto K, Hermanto A and Nuswantoro P 2015 *AIP Conf. Proc.* **1699** 040019
[16] Sumariyah S, Kusminarto K, Hermanto A and Nuswantoro P 2016 *J. Phys.: Conf. Ser.* **776** 012100
[17] Yang M and Changjiang D 2016 *Springer Plus* **5** 909
[18] Ding C Jun L and Zhiqing S 2015 *Plos ONE* **10** 4

C13_Ion wind from yield corona discharge and its application to drying of Turmeric slices (Curcuma domestica Val)

ORIGINALITY REPORT

11%	4%	10%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Sumariyah, , Kusminarto, Arief Hermanto, and Pekik Nurwantoro. "Velocity Measurement of EHD Flow Produced by Pin-Multi Concentric Ring Electrodes Generator", Applied Mechanics and Materials, 2015. Publication	3%
2	docplayer.net Internet Source	2%
3	Taghian Dinani, Somayeh, Nasser Hamdami, Mohammad Shahedi, Michel Havet, and Delphine Queveau. "Influence of the electrohydrodynamic process on the properties of dried button mushroom slices: A differential scanning calorimetry (DSC) study", Food and Bioproducts Processing, 2015. Publication	1%
4	In-Soung Chang, Jae-Hyung Kim. "Development of clean technology in wafer drying processes", Journal of Cleaner Production, 2001 Publication	1%

5	leptir.ifs.hr Internet Source	1 %
6	Xiaohong Yan. "Numerical design of self-pumped electrostatic precipitators for particle collection", Chemical Engineering Research and Design, 2022 Publication	1 %
7	pammc.areeo.ac.ir Internet Source	1 %
8	R. Barathiraja, P. Thirumal, G. Saraswathy, I. Rahamathullah. "Drying of turkey berry in a fluidized bed dryer with mild steel, copper and aluminum inert materials: kinetics and quality determination", Journal of Mechanical Science and Technology, 2021 Publication	1 %

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	On		

C13_Ion wind from yield corona discharge and its application to drying of Turmeric slices (Curcuma domestica Val)

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6