PERFORMANCE EVALUATION OF SOLAR DEHYDRATOR FOR EXCESS PRODUCE

ARVIN JAY B. JIMENEZ

An Undergraduate Thesis Submitted to the Faculty of the Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines
in Partial Fulfillment of the Requirements
for the Degree of

BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING
(Agricultural Mechanization and Renewable Energy)

JUNE 2019

ACCEPTANCE SHEET

This undergraduate thesis entitled **"PERFORMANCE EVALUATION OF SOLAR DEHYDRATOR FOR EXCESS PRODUCE"** prepared and submitted by **ARVIN JAY B. JIMENEZ**, in partial fulfillment of the requirements for the degree of **BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING**, is hereby accepted:

RUEL G. PENEYRA
Member, Advisory Committee

Date Signed

MARLON N. GALAD
Member, Advisory Committee

Date Signed

GELLA PATRIA L. ABELLA
Member, Advisory Committee

Date Signed

MARVIN M. CINENSE
Chairperson, Advisory Committee

Date Signed

Accepted as partial fulfillment of the requirements for the degree of **BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING**:

MARVIN M. CINENSE
Officer-in-Charge, Department of Agricultural and Biosystems Engineering

6/13/19
Date Signed

VICTORINO T. TAYLAN
Dean, College of Engineering

Date Signed

BIOGRAPHICAL SKETCH

The author, Arvin Jay B. Jimenez was born on April 19, 1997 in Cabanatuan City, Nueva Ecija. He is the eldest child of Mr. Arturo D. Jimenez and Mrs. Justina B. Jimenez who were both teachers in profession. He was raised together with his two siblings, namely Aries John B. Jimenez and Aron James B. Jimenez, at Brgy. Gulod,Talavera, Nueva Ecija.

He has completed his basic education at Talavera Central School in Talavera, Nueva Ecija in 2010, and his secondary education as an honor student in Talavera National High School also in Talavera, Nueva Ecija in 2014. He took his tertiary education in Central Luzon State University and enrolled in the degree of Bachelor of Science in Agricultural and Biosystems Engineering on the same year. He was a former altar server and served for almost five years in St. Isidore the Worker Parish, Talavera, Nueva Ecija. During his first year in college, he joined Archery in the University Intramural Games and won a gold medal in team event. Some of the trainings and workshops that he attended were:

- StartUp: "Innovation" and "Technology Entrepreneurship" Forum
  RET Amphitheater, Central Luzon State University, Science City of Muñoz, Nueva Ecija
  March 7, 2019
- Smart Farming: Engraining the Future
  College of Engineering, Central Luzon State University, Science City of Muñoz, Nueva Ecija
  April 11, 2018
- AE Planting Festival
  College of Engineering, Central Luzon State University, Science City of Muñoz, Nueva Ecija
  April 15, 2016
- Symposium on Current Trends in Food Safety and Quality Assurance
  University Gymnatorium, Central Luzon State University, Science City of Muñoz, Nueva Ecija
  August 30, 2014

AKNOWLEDGEMENT

This study would not have been made possible without the idea, knowledge, support, and encouragement of the people who extended their helping hands towards the completion of this research work. Therefore, the author wishes to express his deepest gratitude to the following:

First and foremost, to the Almighty God, for His grace and mercy, guidance and protection, and for making him believe and trust the Lord with all of his heart. To God be all the glory.

Dr. Marvin M. Cinense, Chairperson of the Advisory Committee, for his advice, guidance, encouragement, and for his efforts to provide the important materials used in the study;

Dr. Gella Patria Abella, co-adviser in Institute for Climate Change and Environmental Management (ICCEM) for allowing the conduct of their project and for having lent the equipment used in the study;

Prof. Ruel G. Peneyra and Engr. Marlon N. Galad, members of the Advisory Committee, for their assistance, valuable suggestions, constructive criticisms and positive encouragement;

Dr. Victorino Taylan, Dean of the College of Engineering, for his continuous support and guidance;

To his loving and ever supportive parents, Mr. Arturo D. Jimenez and Mrs. Justina B. Jimenez, for the understanding, encouragement and being patient with everything that he is doing and pursuing. They are an inspiration and a role model to him in becoming who

and what he is now, and in building up his character. Most of all, for trusting and believing in his strengths and capabilities.

To his siblings, Aries John B. Jimenez and Aron James B. Jimenez, for the love and support that he has received.

To all his friends and classmates, especially to Ma. Colleen N. Sarcillo, Kristine Marilou O. Ramos, Nikko O. Salamanca, Klark Kent Romeo Del Rosario, Paulo Gabriel Bernardo and Cris Leniel Cruz, for their support, assistance, suggestions and motivation during the conduct of this thesis.

To all of them, this piece of work is humbly dedicated.

ARVIN JAY B. JIMENEZ

TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

JIMENEZ, ARVIN JAY B., Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines, June 2019, **PERFORMANCE EVALUATION OF SOLAR DEHYDRATOR FOR EXCESS PRODUCE**

Adviser: **MARVIN M. CINENSE, Ph.D.**
Co-Adviser: **GELLA PATRIA L. ABELLA, Ph.D.**

The general objective of the study was to evaluate the performance of solar dehydrator for excess produce (SDEP). The study also aimed to: (1) evaluate the SDEP in terms of air flow, heat energy, temperature and relative humidity; (2) evaluate the SDEP in terms of drying rate, drying time, and moisture content reduction; and; (3) perform a simple cost analysis. The study was conducted at the Institute for Climate Change and Environmental Management, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines from April-May 2019.

The machine efficiently captured the heat of the sun anytime of the day. The color was made black to enhance its heat absorption capacity. Also, solar panel was installed to run the exhaust fan without using any electricity. Inside the drying chamber was composed of three drying trays. The drying process was done from 8:00am to 5:00pm everyday until the weight of the samples became constant.

Results revealed that the airflow of SDEP was 9.55 m/s and the total amount of heat was 457.98 W. In terms of moisture content, okra has the highest moisture content having 11.42 grams of water per gram of dry solid g_w/g_s, followed by mushroom having 7.75 g_w/g_s and onion which has 7.17 g_w/g_s. The samples were dried up to 0.14 g_w/g_s for onion, 0.13 g_w/g_s for mushroom and 0.11 g_w/g_s for okra. The commodities were dried 20% faster using

the solar dehydrator with an average drying rate of 98.71%/hr compared to the traditional method which was the open air sun drying. While the average drying rate of an open air sun drying was 88.08%/hr. The average drying time of onion was 13.89 hours, 5.89 hours for mushroom and 10 hours for okra.

All dried samples were brought to CLSU-AFTBI to test the water activity. The dried samples using solar dehydrator had an average of 0.390 while the samples that were dried in an open air got an average of 0.376. Therefore, drying using SDEP is safe microbial growth.

The computed fixed cost and variable cost of SDEP were Php 8,645/yr and Php 29, 970, respectively. The total cost of drying of was Php 268.16/kg while the breakeven point was 11.81 kg/year.

LITERATURE CITED

ABELLA, G.P., et.al. (2018). *Eco-efficient Solar Dehydrator for Excess Produce (ESDEP)*. Central Luzon State University

ARORA, G., et.al. (2015). *Design of Solar Power Inverter*. Retrieved January 30, 2019, from Researchgate: https://www.researchgate.net/publication/305699065_Design_of_Solar_Power_Inverter

ASHEBIR, D., et.al. (2009). *Change in Color and Other Fruit Quality Characteristics of Tomato Cultivars After Hot-air Drying at Low Final-Moisture Content*. Retrieved January 15, 2019, from International Journal of Food Sciences and Nutrition: https://ucanr.edu/datastoreFiles/608-206.pdf

Axial Fans (Axial Blower). (n.d.). Retrieved January 30, 2019, from Cincinnati Fan: https://www.cincinnatifan.com/axial-fans.htm

CHUNG, D.P. and CHANG, D.I. (1981). Principles of Food Dehydration. *Journal of Food Protection*, 475-478.

DHUMNE, L., et.al. (2015). Solar Dryers for Drying Agricultural Products. International Journal of Engineering Research. Vol. 3

ERASQUIN JR., R.N. & MELENDEZ, B.E. (2001). *Performance Evaluation of the Multi-Purpose Solar Tunnel Dryer for Fish Drying*. (Unpublished undergraduate thesis) Central Luzon State University, Science City of Muñoz

FALADE, K.O, Omojola B.S. (2010). Effect of Processing Methods on Physical, Chemical, Rheological, and Sensory Properties of Okra (*Abelmoschus esculentus*) *Food Bioprocess Technology*. 2010;3:387–394.

GREGORI, A., M. ŠVAGELJ, and J. Pohleven. 2007. Cultivation Techniques and Medicinal Properties of *Pleurotus spp. Food Technology and Biotechnology* 45(3):238–49.

GUPTA, P. e. (2017). Design and Construction of Solar Dryer for Drying Agricultural. *International Research Journal of Engineering and Technology (IRJET)*, 1946.

INTERNATIONAL RICE RESEARCH INSTITUTE. (2013). Paddy Drying. IRRI Rice Knowledge Bank, 17.

KORDYLAS, J.M. (1991). Processing and Preservation of Tropical and Subtropical Foods. UK: Macmillan

KUMAR, A., et.al., (2013) Historical Review and Recent Trends in Solar Drying Systems, International Journal of Green Energy, 10:7, 690-738, DOI: 10.1080/15435075.2012.727113

LAKHANI, J.R., et. al. (2013). *Design and Development of Solar Dryer for Fruit Chips.* Retrieved January 25, 2019, from Researchgate: https://www.researchgate.net/publication/311951730_design_and_development_of_solar_dryer_for_fruit_chips

LARA, G. (2013). *QUICKER AND CLEANER DRYING OF FISH PRODUCTS IN CAGAYAN.* Retrieved December 10, 2018, from Department of Science and Technology: http://www.dost.gov.ph/knowledge-resources/news/33-2013-news/111-dost-sun-dryers-ensure-quicker-and-cleaner-drying-of-fish-products-in-cagayan.html

MADHLOPA, A., et.al. (2002) A Solar Air Heater with Composite-Absorber Systems for Food Dehydration. Renew Energy, 27, 37-27. http://dx.doi.org/10.1016/S0960-1481(01)00174-4

MAFTOUNI, N., et. al. (2016). *A Parametrical Design of a Cabinet Type Solar Dryer.* Retrieved January 24, 2019, from Researchgate: https://www.researchgate.net/publication/316543234_A_parametrical_design_of_a_cabinet_type_solar_dryer

MARTINEZ, H., et.al. (2014). Establishment of Rural Enterprises Using Multi-Commodity Solar Tunnel Dryer Through the Application of Social Laboratory Concept as A Sustainable Technology Transfer Strategy in The Philippines. *Asia Pacific Journal of Sustainable Agriculture Food and Energy (APJSAFE)*, 7-10.

MISHRA, S.A., et.al.,. (2015). *Solar Cabinet Dryer.* Phagwara: Lovely Professional University.

MITRA, J., et.al. (2012). Onion Dehydration: A Review. *Journal of Food Science and Technology*, 267-277. Retrieved January 29, 2019, from NCBI: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3614038/

MUJUMDAR, A. (1988). Handbook of Industrial Drying. *Drying Technology: An International Journal* , 571-573.

MUSTAYEN, A.G., et.al. (2015). Performance Evaluation of a Solar Powered Air Dryer for White Oyster Mushroom Drying. *International Journal of Green Energy*, 12:11, 1113-1121, DOI: 10.1080/15435075.2014.891221.

PAES 248: 2010. Agricultural Machinery – Fruit Dryer

PAES 249: 2010. Agricultural Machinery – Fruit Dryer – Methods of Test

PARIKH, D. (2014). *Solids Drying: Basic and Applications*. Retrieved from Chemical Engineering Online: https://www.chemengonline.com/solids-drying-basics-and-applications/?printmode=1

PATEL, A.H., et.al. (2013). Review on Solar Dryer for Grains, Vegetables and Fruits. *International Journal of Engineering Research and Technology*, 4-10.

PENDRE, N.K., et.al. (2011). Effect of Drying Temperature and Slice Size on Quality of Dried Okra (Abelmoschus esculentus (L.) Moench). *Journal of Food Science and Technology*, 378-381.

POMERANZ, Y., CZUCHAJOWSKA, Z., and LAI, S. L. (1986). Comparison of Methods for Determination of Hardness and Breakage Susceptibility of Commercially Dried Corn. Cereal Chem. 63:39.

SANDULACHI E. (2012). *Water Activity Concept and Its Role in Food Preservation*. Retrieved January 15, 2019, from Researchgate: https://www.researchgate.net/publication/310605656_WATER_ACTIVITY_CONCEPT_AND_ITS_ROLE_IN_FOOD_PRESERVATION

SARSAVADIA, PN, et.al. (1999). Drying Behaviour of Brined Onion Slices. J Food Eng. 1999; 40:219–226. doi: 10.1016/S0260-8774(99)00058-8.

SWAMI, V.M. and ANIL, T.R. (2018). Experimental Analysis of Solar Fish Dryer Using Phase Change Material. *The Journal of Energy Storage*, Vol. 20.

TOLERA, K.D. and ABERA, S. (2017). *Nutritional Quality of Oyster Mushroom (Pleurotus ostreatus) as Affected by Osmotic Pretreatments and Drying Methods*. Retrieved January 27, 2019, from NCBI: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5608979/

WHAT IS A SOLAR PANEL? (n.d.). Retrieved January 30, 2019, from Mr. Solar.com: https://www.mrsolar.com/what-is-a-solar-panel/

YALDIZ O., ERTEKIN C., & UZUN, H. I. (2001). Mathematical Modelling of Thin Layer Solar Drying of Sultana Grapes. *Energy*, 26(5), 457- 465

ZIGLAR, J. (2005). *Batteries: Why are They so Important?* Retrieved January 30, 2019, from SciCom: http://web.mit.edu/scicom/www/battery.html