INFLUENCE OF ACOUSTIC WAVES ON THE SHELF LIFE QUALITY OF BELL PEPPER (*Capsicum annuum* L.)

CRIS LENIEL B. CRUZ

An undergraduate thesis presented to the faculty of the Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University, Science City of Munoz, Nueva Ecija, Philippines
in partial fulfillment of the requirements
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BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING
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ACCEPTANCE SHEET

This undergraduate thesis entitled **"INFLUENCE OF ACOUSTIC WAVES ON THE SHELF LIFE QUALITY OF BELL PEPPER (*Capsicum anuum* L.)"**, prepared and submitted by **CRIS LENIEL B. CRUZ,** in partial fulfillment of the requirements for the degree of **BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING (AGRICULTURAL AND BIO-PROCESS ENGINEERING)**, is hereby accepted:

MELBA D. DENSON, M.Sc.
Member, Advisory Committee

Date Signed

CAROLYN GRACE G. SOMERA, M.Sc.
Member, Advisory Committee

6/13/19
Date Signed

JEFFREY A. LAVARIAS, Ph.D.
Chairperson, Advisory Committee

Date Signed

Accepted as partial fulfilment of the requirements for the degree of **BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING (AGRICULTURAL AND BIO-PROCESS ENGINEERING):**

MARVIN M. CINENSE, Ph.D.
Chairperson, Department of Agricultural and Biosystems Engineering

6/14/19
Date Signed

VICTORINO T. TAYLAN, Ph.D.
Dean, College of Engineering

Date Signed

BIOGRAPHICAL SKETCH

Cris Leniel Baldovino Cruz was born on August 30, 1998 at San Jose City, Nueva Ecija. He is the youngest child of Mr. Crisologo Cruz and Mrs. Segundalina Cruz along with his sister, Charlene Cruz. He is currently living in Brgy. Camanacsacan , San Jose City, Nueva Ecija.

He finished his primary education at San Jose West Central School, San Jose City, Nueva Ecija receiving an honorable mention award, afterwards he taken up his secondary education at Constancio Padilla National High School, San Jose City and graduated at year 2014.

He pursued his tertiary education at Central Luzon State University and as a son of a farmer, he decided to took Bachelor of Science in Agricultural and Biosystems Engineering. He is a DOST-SEI scholar and a pioneering member of CLSU ADS (Association of DOST Scholars). He also attended Summer Practical Training Program sponsored by DOST from June- July 2018 at East West Seed Co., San Ildefonso, Bulacan.

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ABSTRACT

CRUZ, CRIS LENIEL B. Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines. **June 2019. INFLUENCE OF ACOUSTIC WAVES ON THE SHELF LIFE QUALITY OF BELL PEPPER (*Capsicum annuum* L.)**

Adviser: JEFFREY A. LAVARIAS, Ph.D.

Maintaining the shelf life and marketable quality of freshly produced bell pepper remains to be a big challenge. In order to prolong or maintain the marketable quality of this highly perishable crop, application of acoustic waves was proposed. The objective of the study was to evaluate the effect of acoustic wave on the surface color, flesh firmness and shelf life extension of bell pepper.

Bell peppers were exposed to 1KHz, 100 dB acoustic waves in 4, 6 and 8 hours in a sound-proof chamber prior to storage at 5°C. Zero exposure time was assigned as the control treatment in order to determine the influence of application of acoustic waves. The experimental set-up followed Completely Randomized Design (CRD) and the data gathered were statistically analyzed using one way analysis of variance test.

Results showed that bell pepper exposed to acoustic waves had a significant effect on its shelf life quality. Bell pepper treated with acoustic waves for 8 hours gave the best result for the change in surface color and flesh firmness with means equivalent to 3.88 and 3.36, respectively. The highest shelf life of bell pepper was also acquired in the 8 hours exposure to acoustic waves with 31 days. Analysis of variance shows significant effect on flesh firmness and shelf life but no significant effect on the change in surface color of bell pepper.

Based on the results of the study, the optimum exposure time to acoustic waves for the bell pepper was 8 hours which can maintain its marketable quality up to 31 days after storage.

Keywords: acoustic waves; hours of exposure; surface color; flesh firmness; shelf life

LITERATURE CITED

AGARWAl, R. (n.d.). Storage: Meaning, Functions and Need for Storage. Retrieved November 11, 2018, from http://www.yourarticlelibrary.com/business/storage-meaning-functions-and-need-for-storage/42128.

AGBLOR, S. & D. WATERER. (2001). Peppers - Post-Harvest Handling and Storage. Retrieved Novembeer 11, 2018, from http://www.agr.gc.ca/resources/prod /doc/pfra-arap/csidc-crdi/pdf/pepper-piment_eng.pdf.

BAL, E. (2013). Effects of Exogenous Polyamine And Ultrasound Treatment to Improve Peach Storability. Namik Kemal University, Agricultural Faculty, 59030 Tekirdag, Turkey.

BARRETT, D.M. , J.C. BEAULIEU , & R. SHEWFELT. (2010). Color, Flavor, Texture, and Nutritional Quality of Fresh-Cut Fruits and Vegetables: Desirable Levels, Instrumental and Sensory Measurement, and the Effects of Processing. Retrieved November 14, 2018, from http://www.fruitandvegetable.ucdavis.edu/ files/217117.pdf.

BAYOGAN, E.R. , R. SALVILLA , A.M. MAJOMOT & J. ACOSTA. (2017). Shelf life of Two Sweet Pepper (*Capsicum annuum*). Retrieved November 26, 2018, from http://biozoo journals.ro/swjhbe/v8n1/01_swjhbe_v8n1_Bayogan.pdf.

BERHE, D.S. 2013. Effects of Harvesting Stage and Storage Duration on Quality and Shelf Life of Sweet Bell Pepper (Capsicum annuumL.) Varieties under Passive Refrigeration System at Ziway, Ethiopia, Hawassa University, Ethiopia. Retrieved November 11, 2018 at https://www.academia.edu/9142665/Sweet_Bell_Pepper _Postharvest_Quality_Cues.

BISWAS, T. , Z. GUAN , & F. WU. (n.d.). An Overview of the U.S. Bell Pepper Industry . Retrieved November 11, 2018, from https://gcrec.ifas.ufl.edu/media/ gcrecifasufledu/images/zhengfei/FE---Bell-Pepper.pdf.

CANTWELL, M. (1996). Bell Pepper: Recommendations for Maintaining Postharvest Quality. Retrieved November 11, 2018, from http://postharvest.ucdavis.edu/ Commodity_Resources/Fact_Sheets/Datastores/Vegetables_English/?uid=5&ds= 799.

DEPARTMENT OF AGRICULTURE, FORESTRY AND FISHERIES. (2013). Sweet pepper. Retrieved November 10, 2018, from https://www.nda.agric.za /docs/brochures /sweetpepper.pdf.

DOORNE, Y. V. (2000). The Effects of Sound on Living Organisms. Applications in Agriculture. Retrieved November 17, 2018, from http://users.belgacom.net /gc681999/Onderwerpen /Info/Ecosonic.htm.

ENCYCLOPAEDIA BRITANNICA. (n.d.). Storage Goods. Retrieved November 11, 2018, from https://www.britannica.com/technology/storage-goods.

FAO. (n.d.). Basic Harvest And Post-Harvest Handling Considerations For Fresh Fruits And Vegetables. Retrieved November 14, 2018, from http://www.fao.org/docrep/005/y4358e /y4358e05.htm.

FERNIE, A. 2012. Climacteric And Non-Climacteric Fruits React Differently To The Plant Hormone Ethylene. Retrieved on June 1, 2019 at https://www.mpg.de/5934313 /peppers_ethylene_maturity.

FRIDVALSKY, L. and J. NAGY. 1966. The Differentiation, Microscopic And Submicroscopic Structure Of Giant Cell Wall In The Pericarp Of Capsicum Annuum L. Acta Agronomica Academiae Scientiarum Hungaricae 15: 69-78.

HAMEED, R., A. MALIK, A.S. KHAN, M. IMRAM, M. UMAR & R. RIAZ. 2013. Evaluating the Effect of Different Storage Conditions on Quality of Green Chillies (Capsicum annuum L.) Postharvest Research and Training Centre Institute of Horticultural Sciences University of Agriculture Faisalabad, Pakistan.

HASSANIEN, R., E. HASSANIEN , B. LI , Y. LI & T.Y. HOU. (2014). Advances in Effects of Sound Waves on Plants. Retrieved November 25, 2018, from https://www.researchgate.net/publication/260167970_Advances_in_Effects_of_Sound_Waves_on_Plants.

HERBST, S. T. (2001). The New Food Lover's Companion: Comprehensive Definitions of Nearly 6,000 Food, Drink, and Culinary Terms. Barron's Cooking Guide. Hauppauge, NY: Barron's Educational Series.

HERLIHY, K. (2014). Factors That Affect Food Storage: How to Keep Your Emergency Supply Safe for Consumption. Retrieved November 11, 2018, from http://www.survivalbased.com/survival-blog/2506/factors-that-affect-food-storage-how-to-keep-your-emergency-supply-safe-for-consumption/.

KAISER, C. & M. ERNST. (2018). Bell Peppers. Retrieved November 11, 2018, from http://www.uky.edu/ccd/sites/www.uky.edu.ccd/files/bellpeppers.pdf.

KIM, J.Y., J. LEE, T. KWON, S. LEE, J.A. KIM, G.M. LEE, S. PARK & M. JEONG-JEONG (2015). Sound waves delay tomato fruit ripening by negatively regulating ethylene biosynthesis and signaling genes. Retrieved Novemeber 25, 2018, from https://www.sciencedirect.com/science/article/pii/S0925521415300636.

KRISHAN, S. (2013). 9 Incredible Health Benefits of Bell Peppers. Retrieved November 11, 2018, from https://www.care2.com/greenliving/9-incredible-health-benefits-of-bell-peppers.html.

MARIANO, J.S. , & E.F. JIMENEZ. (n.d.). Bell Pepper. Retrieved November 11, 2018, from http://bpi.da.gov.ph/bpi/images/Production_guide/pdf/BELL%20 PEPPER%20.pdf.

MENDOZA, V. (2005). Characterization Of Surface Appearance And Color In Some Fruits And Vegetables By Image Analysis. Retrieved November 14, 2018, from http://www.lth.se/fileadmin/livsmedelsteknik/pers_hemsidor/collab/THESIS2005_FMendoza_UC-Chile.pdf.

MINNICKS, M. (2018). Bell Peppers: Differences Between Green, Yellow, Orange, and Red. Retrieved november 10, 2018, from https://delishably.com/vegetable-dishes/Whats-The-Difference-Red-Orange-Yellow-And-Green-Bell-Peppers.

MITCHAM, B. , M. CANTWELL & A. KADER. (1996). Methods for Determining Quality of Fresh Commodities. Retrieved November 14, 2018, from http://ucce.ucdavis.edu/files/ datastore/234-49.pdf.

MVUMI, C. (2013). Assessing the Effect of Adequate and Inadequate Inorganic Fertilizer Rates on the Yield Levels of Paprika in Mutasa Resettlement Area, Manicaland Province, Zimbabwe. Retrieved November 11, 2018, from http://www.gjournals.org/gjas/gjas% 20pdf/2013/march/mvumi%202.pdf.

NEW WORLD ENCYCLOPEDIA. (2008). Paprika. Retrieved November 11, 2018, from http://www.newworldencyclopedia.org/entry/Paprika.

PANDEY, R. (2015). What are acoustic waves? Retrieved November 17, 2018, from https://www.quora.com/What-are-acoustic-waves.

PATRICK, C. (2017). What are the different uses of refrigerators? Retrieved November 25, 2018, from https://www.quora.com/What-are-the-different-uses-of-refrigerators.

PHILIPPINE NATIONAL STANDARD. (2009). Fresh vegetables-Sweet Pepper-Grading and Classifications (PNS/BAFPS 78:2009). ICS 65.020.20.

PHILIPPINES STATISTIC AUTHORITY. (2018). Supply Utilization Accounts of Selected Agricultural Commodities. Retrieved November 25, 2018, from https://psa.gov.ph /sites/default/files/sua_12-14.pdf.

PUJOL, R. (2018). Frequencies Perceived By Man and Some Mammals. Retrieved November 17, 2018, from https:// http://www.cochlea.org/en/hear/human-auditory-range.

SABA. (2017). 20 Amazing Benefits Of Capsicum/Bell Peppers (Shimla Mirch) For Skin, Hair And Health. Retrieved november 11, 2018, from https://www.stylecraze.com/articles/amazing-benefits-of-bell-peppers-for-skinhair - and-health /#gref.

SAINI, G. K. (2018). Extending The Shelf Life Of Agricultural Products: Five Approaches For Success. Retrieved November 14, 2018, from https://globalfoodsafetyresource.com /extending-the-shelf-life-of-agricultural-products-five-approaches-for-success/.

SEMCO Inc. (2014). Effective Post-harvest Cooling and Storage of Peppers. Retrieved November 11, 2018, from https://semcoice.com/cooling/effective-post-harvest-cooling-peppers/.

SHIQIN, T. S. (n.d.). Investigating the Effects of Sound Energy on Plant Growth. Retrieved November 17, 2018, from http://musique-pour-soigner-les-plantes.weebly.com/ uploads/5/1/5/9/51596/tanshen-study_music_plants_ mais_ 2009 .pdf.

SIYABULA. (n.d.). Characteristics Of A Sound Wave. Retrieved November 17, 2018, from https://www.siyavula.com/read/science/grade-10/sound/10-sound-03.

SUZUKI, T. , H. FUJIWAKE and K. IWAI. 1980. Intracellular localization of capsaicin and its analogues in Capsicum fruit. 1. Microscopic investigation of the structure of the placenta of Capsicum annuum var. annuum cv. Karayatsubusa. Plant and Cell Physiology 21: 839-853.

PHILIPPINE NATIONAL STANDARD. (2009). Fresh vegetables-Sweet Pepper-Grading and Classifications (PNS/BAFPS 78:2009). ICS 65.020.20.

PHILIPPINES STATISTIC AUTHORITY. (2018). Supply Utilization Accounts of Selected Agricultural Commodities. Retrieved November 25, 2018, from https://psa.gov.ph /sites/default/files/sua_12-14.pdf.

PUJOL, R. (2018). Frequencies Perceived By Man and Some Mammals. Retrieved November 17, 2018, from https:// http://www.cochlea.org/en/hear/human-auditory-range.

SABA. (2017). 20 Amazing Benefits Of Capsicum/Bell Peppers (Shimla Mirch) For Skin, Hair And Health. Retrieved november 11, 2018, from https://www.stylecraze.com/articles/amazing-benefits-of-bell-peppers-for-skinhair - and-health /#gref.

SAINI, G. K. (2018). Extending The Shelf Life Of Agricultural Products: Five Approaches For Success. Retrieved November 14, 2018, from https://globalfoodsafetyresource.com /extending-the-shelf-life-of-agricultural-products-five-approaches-for-success/.

SEMCO Inc. (2014). Effective Post-harvest Cooling and Storage of Peppers. Retrieved November 11, 2018, from https://semcoice.com/cooling/effective-post-harvest-cooling-peppers/.

SHIQIN, T. S. (n.d.). Investigating the Effects of Sound Energy on Plant Growth. Retrieved November 17, 2018, from http://musique-pour-soigner-les-plantes.weebly.com/ uploads/5/1/5/9/51596/tanshen-study_music_plants_ mais_ 2009 .pdf.

SIYABULA. (n.d.). Characteristics Of A Sound Wave. Retrieved November 17, 2018, from https://www.siyavula.com/read/science/grade-10/sound/10-sound-03.

SUZUKI, T. , H. FUJIWAKE and K. IWAI. 1980. Intracellular localization of capsaicin and its analogues in Capsicum fruit. 1. Microscopic investigation of the structure of the placenta of Capsicum annuum var. annuum cv. Karayatsubusa. Plant and Cell Physiology 21: 839-853.

THORUP, T.A. , B. TANYOLAC , K.D. LIVINGSTONE , S. POPOVSKY , I. PARAN and M. JAHN. 2000. Candidate gene analysis of organ pigmentation loci in the Solanaceae. Proceedings of the National Academy of Sciences (USA) 97: 11192-11197.

TUQUERO, J. & J. BAMBA. (2016). Bell Pepper (Capsicum annuum):A Potential Commercial Crop for Guam. Retrieved november 11, 2018, from http://cnas-re.uog.edu/wp-content /uploads/2016/09/Bell_Pepper_8_16_FINAL.pdf.

UNIVERSAL CLASS INC. (2018). The Physics Behind Acoustic Waves. Retrieved November 17, 2018, from https://www.universalclass.com/articles/ science/ physics/the-physics-behind-acoustic-waves.htm.