GRADUATE AND POSTDOCTORAL STUDIES

McGILL UNIVERSITY

FINAL ORAL EXAMINATION
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

OF

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DEPARTMENT OF BIORESOURCE ENGINEERING
POSTHARVEST QUALITY MANAGEMENT OF CUCUMBER AND EGGPLANT

June 9th, 2015
1:15 p.m.

Macdonald Stewart Building – Room MS2-022
McGill University, Macdonald Campus

COMMITTEE:
Dr. I. Strachan (Pro-Dean) (Natural Resource Sciences)
Dr. V. Orsat (Chair) (Bioresource Engineering Department)
Dr. M.O. Ngadi (Supervisor) (Bioresource Engineering Department)
Dr. G.S.V. Raghavan (Internal Examiner) (Bioresource Engineering Department)
Dr. M-J. Dumont (Internal Member) (Bioresource Engineering Department)
Dr. S. Karboune (External Member) (Food Science and Agricultural Chemistry Department)

Dr. T. Kreiswirth, Dean of Graduate and Postdoctoral Studies
Members of the Faculty and Graduate Students
are invited to attend

ABSTRACT

One-third of global food produced for human consumption, which amounts to about 1.3 billion tons is lost or wasted annually. Measuring postharvest losses is an essential operational strategy to enhance postharvest management and to curtail quality loss of fresh horticultural commodity. The goal of this study was to develop and test different methods that characterize and quantify postharvest losses of cucumber and eggplant in St. Kitts-Nevis and Guyana. The study also allowed investigating the influence of temperature and light on quality changes during handling practices of freshly harvested crops.

Three approaches were deployed in the study. The first approach consisted of field-based activities in St. Kitts-Nevis and Guyana using producer household surveys (PHS) and modified count and weight (MCW) method. Results from PHS baseline surveys revealed that farmers sell most of their harvested crops to local markets, keeping the remaining crops for household consumption. In Guyana, the majority of farmers (97%) reported selling their crops at harvest, while in St. Kitts-Nevis, 61% of farmers stored them before selling. While farmers in St. Kitts-Nevis reported 30% postharvest losses of crops due to spoilage, those in Guyana reported considerably less. Results from modified count and weight method revealed that small producers experienced greater postharvest loss compared to large ones due to spoilage and lack of market access. As the produce travelled throughout the supply chain, it started to lose significantly ($P < 0.05$) its freshness and its marketable value as well. This loss was due to inappropriate handling and exposure to undesirable environmental conditions.

The second approach entailed laboratory-based work to simulate the environmental conditions during postharvest handling process in the studied countries. This approach was associated with activities investigating the effect of constant and fluctuating environmental factors including temperature and light on quality changes of eggplant and cucumber such as color, texture, weight loss, quality index and phytochemical content. Under isothermal conditions, four storage combinations of temperatures and light were studied for 10 day-period as follow: SC1=10°C/with light, SC2=30°C/with light, SC3=10°C/without light, and SC4=30°C/without light. Under non-isothermal conditions, another four combinations of temperatures and light were conducted (S1=25°C/2 hours without light, S2=25°C/3 hours with light, S3=30°C/12 hours with light and 20°C/12 hours without light for a total of 72 hours, and S4=10°C/144 hours without light). This scenario represented all steps of the supply chain of fresh produce starting at the producer level, followed by the distributor, the retailer and end up at the consumer level. Major postharvest losses occurred after 10 days of storage at 30°C in the presence of light. Under these conditions, the firmness of eggplant samples decreased from 5.31 N to 0.77 N (85.5% loss), the weight loss increased up to 21%, significant ($P < 0.05$) color difference was observed, and the crops became unmarketable after 8 days of storage. However, when the crops were wrapped using food grade polyethylene film, quality losses were reduced

significantly ($P < 0.05$) with the exception of color attribute. Under non-isothermal conditions, the majority of losses happened after 77-hour period of storage (S3) due to the effect of fluctuating temperature and light every 12-hour period. Crude extracts of freeze-dried produce were used to determine the total phenolic contents (TPC) using the Folin-Ciocalteau method. Exposing vegetables to high temperature (30°C) and direct light was found to significantly degrade their phenolic content. However, a rise in TPC was observed ($P < 0.05$) when the crops were maintained at 10°C in complete darkness. In addition, storage at fluctuating environmental conditions was found to be the main driver to worsen the phenolic degradation in fresh eggplant (49.7% loss) and cucumber (83.8% loss). Kinetic models were used to provide a structural framework for quantitatively describing and predicting those losses.

In the third approach, the Taguchi method was used to quantify postharvest quality loss of both cucumber and eggplant and to optimize environmental conditions during handling process. To date Taguchi method has been widely and successfully used in various subject areas, but no application of this method to postharvest quality management has been reported until the present time. The experimental design included the 4 three-level factors and an L-9 orthogonal array. Traditionally, the Taguchi approach was used to express the loss in monetary terms. For the purpose of the study, the word "*loss*" means the loss of quality and is expressed in unit scale. The results revealed that fresh cucumber lost some of its quality attributes immediately after harvest. At firmness of 15.68 N, the loss was equivalent to 13.68 units. However, at 7.68 N firmness, the loss value was increased by almost 4 times (56.98 units). In terms of quality index (QI), it was noticed that even when the score was high (QI = 9 points), the produce had lost 8.74 units of its quality. In theory, the only time when the loss is equal to zero is when the cucumber fruit is still attached to its mother plant. When the quality index dropped to 1.67 points, the loss was increased by almost 30 times more (loss = 254.91 units). The results showed how large the extent of loss could be when fresh cucumber is stored under undesirable conditions. Taguchi approach was successfully used to quantify and to predict postharvest quality losses in response to different combinations of environmental factors and their levels. In addition, this approach enabled the identification of optimum conditions of temperature, light and relative humidity, for the storage of fresh produce.

CURRICULUM VITAE

UNIVERSITY EDUCATION

PhD. (Bioresource Engineering) **2012-2015**
McGill University

MSC. (BIORESOURCE ENGINEERING) **2004-2005**
MCGILL UNIVERSITY

BSC. (AGRICULTURE ENGINEERING/FOOD SCIENCE) **1998-2003**
USEK UNIVERSITY AND MCGILL UNIVERSITY

EMPLOYMENT

Adjunct Professor **2015/Present**
HOLY SPIRIT UNIVERSITY KASLIK, Agri-Food Department, Lebanon

External Consultant and Expert **2012/Present**
UNITED NATIONS - ECONOMIC AND SOCIAL COMMISSION FOR WESTERN ASIA

Operations Manager **2010/2011**
CONSERVES MODERNES CHTAURA, Lebanon

Operations Manager **2007/2010**
SNOBIZ, Montreal, Canada

Director of Production **2005/2007**
CIARA TECHNOLOGIES, Montreal, Canada

AWARDS

- Received the McGill Graduate Excellence Award in 2012, 2013, 2014 & 2015.
- Received the International Development Research Centre Award in 2012, 2013 & 2014.
- Received a scholarship from Agriculture and Agri-food Canada in 2004.

PUBLICATIONS

Cortbaoui, P. and M. Ngadi. **2015.** *Influence of fluctuating environmental factors on phytochemical changes in eggplant and cucumber during postharvest storage.* (Submitted)

Cortbaoui, P. and M. Ngadi. **2015.** *Quantifying quality changes in dark purple eggplant as affected by fluctuating storage conditions and wrapping materials.* (Submitted)

Cortbaoui, P. and M. Ngadi. **2015.** *A new method to quantify postharvest quality loss of cucumber using the Taguchi approach.* (Submitted)

Cortbaoui, P. and M. Ngadi. **2015.** *Optimization of postharvest handling process of eggplant using the Taguchi technique.* (Submitted)

Cortbaoui, P. and M. Ngadi. **2015.** *Characterization of postharvest practices and losses of fresh produce along the Caribbean supply chain: Guyana and St. Kitts-Nevis.* (Submitted)

Isaac, W. A., G. Eudoxie, **P. Cortbaoui** and S. Borucki. **2014**. *Caribbean health: Diversity in local food production to combat obesity*. Canada's International Research Centre.

Isaac, W. A., G. Eudoxie, **P. Cortbaoui**, W. Ganpat and S. Borucki. **2014**. *Agricultural technologies bring healthy diversity to school meals*. Canada's International Research Centre.

Nejdawi, R., **P. Cortbaoui** and C. Hebting, **2014.** *Green agricultural value chains for improved livelihood in the Arab region.* Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH/Federal Ministry for Economic Cooperation and Development (BMZ) and Sustainable Development and Productivity Division (SDPD) of the Economic and Social Commission for Western Asia (ESCWA), United Nations, New York.

Vigneault, C., B. Goyette, Y. Gariépy, **P. Cortbaoui,** M.T. Charles and G.S.V. Raghavan. **2007**. *Effect of ear orientations on hydrocooling performance and quality of sweet corn*. Postharvest Biology and Technology – Elsevier, Vol. 43(3): 351 – 357.

Cortbaoui, P., B. Goyette, Y. Gariépy, M.T. Charles, G.S.V. Raghavan and C. Vigneault. **2006**. *Forced-air cooling system for Zea mays*. International Journal of Food, Agriculture & Environment – IJFAE, Vol. 4(1): 100-104.

Cortbaoui, P., C. Vigneault, M.T. Charles, B. Goyette and G.S.V. Raghavan. *Assessment of Precooling Technologies for Sweet Corn*. American Society of Agricultural and Biological Engineers. Annual International Meeting, Tampa, FL, July 17-20, **2005**. Paper #056075.