Prediction of storage potential and firmness loss of ‘Hayward’ kiwifruit along the supply chains in India

A thesis submitted in partial fulfilment of the requirements for the degree of

Master of Food Technology

Massey University,

Albany Campus, New Zealand

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February, 2012

ABSTRACT

Introduction: The ‘Hayward’ kiwifruit (*Actinidia deliciosa* (A. Chev.) C.F. Liang and A.R. Ferguson) is one the most common commercial variety grown in New Zealand. The long shelf-life of the ‘Hayward’ kiwifruit along with its inherent properties such as flavour, colour, texture and high content of vitamin C has allowed the development of New Zealand kiwifruit exports. However, the quality of the fruit can be affected by factors such as storage time and temperature along the supply chains to different markets. Temperature is one the major environmental factors influencing the quality and flesh firmness of the ‘Hayward’ kiwifruit. The softening of kiwifruit can be affected by increase in the environmental temperatures, leading to the deterioration of fruit quality. The aim of this study was to investigate changes in physiochemical parameters of kiwifruit along the supply chains to Indian markets, as well as development of predictive mathematical models for the loss of flesh firmness and storage potential of ‘Hayward’ kiwifruit along these supply chains.

Materials and Methods: The ‘Hayward’ kiwifruit grown in the regions of Bay of Plenty, New Zealand, were selected for this study. Three supply chains were identified through three local kiwifruit distributors based in India. Eighteen kiwifruit trays (six trays, each from three different grower lines) were selected for analysis along each supply chain. At each analysis point along the three supply chains, the ‘On arrival’ and ‘At departure’ quality of twenty fruits were analysed for flesh firmness (kgf), soluble solids content (%Brix) and core temperatures (°C). The flesh firmness of the fruit was measured using a penetrometer and the soluble solids content was measured using a refractometer. The core temperature of the fruit was determined using a core thermometer. The environmental temperature during storage and transportation along the supply chains were recorded using data loggers. Three fruit firmness loss models: Simple Exponential, Boltzmann and Inverse Exponential Polynomial were used to characterise the flesh firmness data collected along each supply chain. The Akaike Information Criteria (AIC) test was used to determine the most suitable model that characterised the flesh firmness loss along these supply chains. Three storage potential models: Reciprocal, Power and Reciprocal Quadratic, were fitted to the flesh firmness and core temperature data collected along each supply chain. The best model to predict the storage potential of kiwifruit was also determined by the AIC test.

Results: The flesh firmness decreased significantly ($P<0.05$) in all the grower lines along the three supply chains. The flesh firmness of kiwifruit decreased to the average level of commercial acceptability (1 kgf) within six to eight days of storage and transportation and further reductions were observed along the supply chains. The soluble solids content increased significantly ($P<0.05$) in kiwifruit belonging to the different grower lines with the variation in storage and transportation temperatures along the three supply chains. The Simple Exponential model best characterised the firmness data collected along Supply Chains 1 and 3, and the Boltzmann model was the second best model that characterised the firmness loss followed by the Inverse Exponential Polynomial model. Changes in the flesh firmness of the fruit along Supply Chain 2 were best characterised by the Boltzmann model followed by the Inverse Exponential Polynomial and Simple Exponential models. Among the three storage potential models, the Reciprocal model best fitted the data on flesh firmness and core temperature, collected in this study. The Power model was the second best storage potential model that characterised the data collected along the three supply chains. The Reciprocal Quadratic model was the least suitable model that characterised the flesh firmness and core temperature data in this study.

Conclusion: The flesh firmness and the soluble solids content of 'Hayward' kiwifruit were affected by temperature variations during storage and transportation along the three supply chains in India. The Simple Exponential model best characterised the flesh firmness data collected along Supply Chains 1 and 3 while the Boltzmann model best characterised the firmness data along Supply Chain 2. The Reciprocal model was the best model to characterise the flesh firmness and core temperature data in this study. The developed storage potential models can be used to determine the shelf-life of kiwifruit along similar supply chains to other markets.

ACKNOWLEDGEMENTS

The completion of my postgraduate studies in Food Technology at Massey University would have been impossible without the support and the help of several individuals and organizations.

First and foremost, I wish to acknowledge the financial support given by Zespri International Limited and the Ministry of Science and Technology (MSI) to conduct this project.

I am highly indebted to Dr Frank Bollen, In-Transit Fruit Conditioning Manager at Zespri International Limited, for his guidance and constant inspiration as well as for providing necessary information regarding the project. I would like to thank Alistair Mowat and Dr Greg Clark for creating an opportunity for me to work in this project. My deepest appreciation goes to Ian Stevens and his colleagues at AgFirst for training me during this study. I would also like to thank Ritesh Bhimani for his help during my stay in India.

I offer my sincerest gratitude to my supervisor, Dr. Tony Mutukumira, for his supervision, advice and guidance from the very early stage of this research. His crucial contribution and supervision has made him a backbone to this research and so to this report. Above all and most needed he provided me unflinching encouragement and support in various ways without which the completion of this project would not have been possible.

I gratefully acknowledge my co-supervisor, Alan Win, for his supervision and encouragement which helped me to complete this project. I would also like to thank him for sharing his views and ideas in moulding the project. I would like to thank Dr Daniel Walsh for helping me with the statistical analysis.

Words fail me to express my appreciation to my family whose love and persistent confidence in me have got me where I am today. I am grateful for their continuous support and help in achieving my goals and fulfilling my dreams. I would like to thank Sadia Seemeen, my best friend for her support during the research. I am extraordinarily fortunate in having Sandeep Patil as my partner. His love, support and encouragement has made this project a great success.

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ABBREVIATIONS

AIC	=	Akaike Information Criteria
ACC	=	1 aminocyclopropane-1-carboxylic acid
ANOVA	=	Analysis Of Variance
ATO	=	Agricultural Trade Office
CA	=	Controlled atmosphere
CSIRO	=	Commonwealth Scientific and Industrial Research Organisation
CT	=	Core temperature
DD	=	Degree-days
FEFO	=	First expire, first out
FF	=	Flesh firmness
FIFO	=	First in, first out
GAP	=	Good Agricultural Practice
HDPE	=	High Density Polyethylene
IEP	=	Inverse Exponential Polynomial
MA	=	Modified atmosphere
NTC	=	Negative temperature coefficient
PET	=	Polyethyleneteraphthalate
R&D	=	Research and Development
RH	=	Relative humidity
SAM	=	s-adenosylmethionine
SE	=	Simple Exponential
SEM	=	Scanning electron microscope
SSC	=	Soluble solids content
TA	=	Titratable acidity
WTC	=	White core inclusions