World Academy of Science, Engineering and Technology
International Journal of Agricultural and Biosystems Engineering
Vol:12, No:03, 2018

Analysis of Vibration and Shock Levels during Transport and Handling of Bananas within the Post-Harvest Supply Chain in Australia

Authors : Indika Fernando, Jiangang Fei, Roger Stanley, Hossein Enshaei

Abstract : Delicate produce such as fresh fruits are increasingly susceptible to physiological damage during the essential post-harvest operations such as transport and handling. Vibration and shock during the distribution are identified factors for produce damage within post-harvest supply chains. Mechanical damages caused during transit may significantly diminish the quality of fresh produce which may also result in a substantial wastage. Bananas are one of the staple fruit crops and the most sold supermarket produce in Australia. It is also the largest horticultural industry in the state of Queensland where 95% of the total production of bananas are cultivated. This results in significantly lengthy interstate supply chains where fruits are exposed to prolonged vibration and shocks. This paper is focused on determining the shock and vibration levels experienced by packaged bananas during transit from the farm gate to the retail market. Tri-axis acceleration data were captured by custom made accelerometer based data loggers which were set to a predetermined sampling rate of 400 Hz. The devices recorded data continuously for 96 Hours in the interstate journey of nearly 3000 Km from the growing fields in far north Queensland to the central distribution centre in Melbourne in Victoria. After the bananas were ripened at the ripening facility in Melbourne, the data loggers were used to capture the transport and handling conditions from the central distribution centre to three retail outlets within the outskirts of Melbourne. The quality of bananas were assessed before and after transport at each location along the supply chain. Time series vibration and shock data were used to determine the frequency and the severity of the transient shocks experienced by the packages. Frequency spectrogram was generated to determine the dominant frequencies within each segment of the post-harvest supply chain. Root Mean Square (RMS) acceleration levels were calculated to characterise the vibration intensity during transport. Data were further analysed by Fast Fourier Transform (FFT) and the Power Spectral Density (PSD) profiles were generated to determine the critical frequency ranges. It revealed the frequency range in which the escalated energy levels were transferred to the packages. It was found that the vertical vibration was the highest and the acceleration levels mostly oscillated between ± 1g during transport. Several shock responses were recorded exceeding this range which were mostly attributed to package handling. These detrimental high impact shocks may eventually lead to mechanical damages in bananas such as impact bruising, compression bruising and neck injuries which affect their freshness and visual quality. It was revealed that the frequency range between 0-5 Hz and 15-20 Hz exert an escalated level of vibration energy to the packaged bananas which may result in abrasion damages such as scuffing, fruit rub and blackened rub. Further research is indicated specially in the identified critical frequency ranges to minimise exposure of fruits to the harmful effects of vibration. Improving the handling conditions and also further study on package failure mechanisms when exposed to transient shock excitation will be crucial to improve the visual quality of bananas within the post-harvest supply chain in Australia.

Keywords : bananas, handling, post-harvest, supply chain, shocks, transport, vibration
Conference Title : ICMPT 2018 : International Conference on Modern Postharvest Technology
Conference Location : Singapore, Singapore
Conference Dates : March 22-23, 2018