Title Development of radio frequency identification (RFID) temperature tracking systems for food supply chains

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Abstract

Food items require temperature controlled supply chains since exposure to certain temperature conditions can diminish product quality and create safety threats. Temperature tracking systems should then be in place in order to monitor the temperature management along their supply chains. Radio frequency identification (RFID) has been suggested as having the potential to become an enhanced temperature tracking method; yet, very few studies have explored the subject in depth. Furthermore, practical details about its application, such as the proper use of RFID tags with probe and without them, how to surpass environmental interactions taking place along the supply chain or how to achieve relevant monitoring keeping the costs down, and the economic benefit it will bring to the food industry still remain unclear. The following work aims to offer insight on these matters and to create viable applications for the technology in real-life food supply chains.

Four objectives were established: 1) To compare the performance of RFID temperature tags versus conventional temperature tracking methods in a food supply chain; 2) To compare the utilization of RFID temperature tags with probe and without them along a food supply chain; 3) To determine the level of instrumentation (amount of sensors and the best locations for their placement) of an efficient temperature tracking system in three different scenarios for food supply chains (For products prone to low and high temperature abuse, for products susceptible to high temperature abuse, and for shelf-stable products); and 4) To create the business case for a RFID temperature tracking system when combined with shelf-life prediction software by performing an economic analysis in one of the systems previously designed.

In order to achieve the first three objectives, a shipping trial was performed with crownless pineapples; while spherical water bottles mimicking produce and First Strike Rations (FSRs) were subjected to thermal relevance and readability studies for the third one. Additionally, software material allowing temperature estimations inside the pallet of FSRs and shelf-life prediction were developed as support material for objectives three and four. Finally, a return on investment (ROI) study was performed for a load management system based on the final monitoring system developed for FSRs.

Results indicate that, although analogous with respect to accuracy in the temperature measurements, RFID systems are superior as temperature tracking method to conventional methods. In addition, RFID tags with probe are important to monitor the critical points of the load, which are the areas of the load where temperature abuse is most likely to occur inside the product; while RFID tags without probes are relevant during monitoring of ambient conditions during storage and transportation. Also, a monitoring system for crownless pineapples was designed, which in some cases involved the use of more than one tag per pallet. Moreover, RFID monitoring systems were also designed for loads of certain varieties of produce such as apples, oranges, pomegranates, passion fruit and tangerines, and for FSRs; but these allowed the use of only one tag per pallet. Lastly, the Return on Investment (ROI) analysis of the RFID-based load management system designed for FSRs was calculated to be 719.49%; which proved that this technology can be an important tool for value generation in food supply chains.