



ELSEVIER

available at www.sciencedirect.comjournal homepage: www.elsevier.com/locate/compag

Spatial temperature profiling by semi-passive RFID loggers for perishable food transportation

Reiner Jedermann^a, Luis Ruiz-Garcia^{b,*}, Walter Lang^a

^a Microsystems Center Bremen (MCB), University of Bremen, Otto Hahn Allee NW1 - D-28359 Bremen, Germany

^b Laboratorio de Propiedades Físicas y Tecnologías Avanzadas en Agroalimentación (LPF-TAG), Universidad Politécnica de Madrid, E.T.S.I. Agrónomos, Avda. Complutense s/n 28040 Madrid, Spain

ARTICLE INFO

Article history:

Received 26 December 2007

Received in revised form

12 August 2008

Accepted 18 August 2008

Keywords:

Semi-passive RFID

Temperature monitoring

Food transportation

ABSTRACT

Perishable food products are at risk of suffering various damages along the cold chain. The parties involved should control and monitor the conditions of goods in order to ensure their quality for consumers and to comply with all legal requirements. Among environmental parameters during transport, temperature is the most important in prolonging the shelf life of the products. Radio Frequency Identification (RFID) is an emergent technology that has proven its suitability for tracking and tracing in logistics. This paper shows how miniaturized RFID temperature loggers can be adapted to analyze the amount of local deviations, detect temperature gradients, and estimate the minimum number of sensors that are necessary for reliable monitoring inside a truck or container. These devices are useful tools for improving the control during the transport chain and detecting weaknesses by identifying specific problem areas where corrective actions are necessitated. In a first step, the RFID tags were tested by studying the temperature distribution in a pallet. Then, 15 shipments from a wholesale company in Germany in compartmented trucks were monitored, covering different temperature range conditions. During transport, several temperature differences were found in the same compartment. Using a factorial Analysis of Variance (ANOVA) the influence of different factors has been studied, such as: the location of the logger, type of truck, and external temperature. The shelf life, or keeping quality model, was applied to the recorded temperature profiles. Suggestions for future research areas are also discussed.

© 2008 Elsevier B.V. All rights reserved.

1. Introduction

The internal biological and chemical processes of fresh produce continue after harvesting. Produce is a living, breathing commodity, which emits heat and carbon dioxide. The risk of a failure in the cold chain could cause excessive ripening, weight loss, softening, color and texture changes, physical degradation and bruising, and attack by rot and molds. These factors affect freshness, desirability, and marketability. Therefore, temperature is the most important factor when prolonging the

practical shelf life of produce. The aim of the freight owner is to ensure that the product is delivered to the end user in an excellent and fresh condition, enhancing the reputations of producers and suppliers as integral parts of the whole transaction. The main interest of the transport operator is in knowing whether the condition of a delivered item is satisfactory or needs additional examination because of an emergent risk of contamination or unwanted ripening.

Radio Frequency Identification (RFID) is an emergent technology that is being used increasingly in many applications.

* Corresponding author.

E-mail address: luis.ruiz@upm.es (L. Ruiz-Garcia).

0168-1699/\$ – see front matter © 2008 Elsevier B.V. All rights reserved.

doi:10.1016/j.compag.2008.08.006