AN AUTOMATIC SYSTEM FOR GENERATING THERMAL MAPS IN VESSEL HOLDS FOR MONITORING THE CORRECT APPLICATION OF THE QUARANTINE PROTOCOL AGAINST THE MEDITERRANEAN FRUIT FLY

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The presence of Mediterranean fruit fly (Ceratitis capitata Wied.), not only in the Meditarranean area but also in other temperate climate countries makes difficult the exports of fruits and vegetables to other places in the world that can be sensible to this pest (i.e. southern USA). The infestation of this fly is difficult to observe in the packing house, since it locates very small eggs in the flesh of the fruit without producing important, easily visible damages to the skin. In order to avoid non-desired propagation of the pest, quarantine protocols have been established to assure that the larvae will be killed during the transport of the fruit in refrigerated vessels or containers and will not develop in the country of destination.

These quarantine protocols normally define the duration of the cold treatment as a function of the maximum temperature reached during the transport of the fruit. Depending of certain temperature thresholds, the shipment has to suffer more or less days of treatment (Table 1). However, logically, the longer the treatment, the higher quality decay, thus decreasing the price of the product.

Table 1.- Summary of quarantine protocol for Spanish clementine exports to USA

Days of treatment	Max. Temperature
14	1.1 °C (34 °F)
16	1.7 °C (35 °F)
18	2.2 °C (36 °F)

For these reasons, an adequate monitoring of the air and fruit pulp temperature is required. Due to the large variety of vessels and holds that are approved for cold treatment under commercial shipping conditions, it is very possible the existence of spots where the fruits are suffering an overcooling, and/or warm spots where the protocol is not completed. Therefore, it becomes necessary to elaborate thermal maps in vessel holds in order to knowing the real temperature conditions during a determined cold treatment. At the same time, the differences of temperature between the various duration periods established in the protocol are very narrow, and close to the accuracy of commercial probes and data loggers. Consequently, important metrological

issues (like calibration, repeatability, accuracy, etc.) of the whole measuring and recording system are critical.

The objective of this work is to develop an automatic system capable of generating a thermal map of a refrigerated ship hold storing bulk or containerised fruit. In parallel, this work also requires to propose an adequate protocol to calibrate the measuring and recording system and a procedure to check if the metrological features of this system have not varied during the shipment.

In the tests, temperature probes (Platinum Resistance Temperature Detectors) are connected to a portable data logger. Some of them are used to determine the air temperature, while others the flesh temperature (figure 1). Four wire resistance measurements allow to avoid the influence of the distance between the measurement point and the acquisition point. Several methods, like the Boltzman lattice model can be used as a framework for modelling the air flow, and consequently, the evolution of the distribution of temperatures.

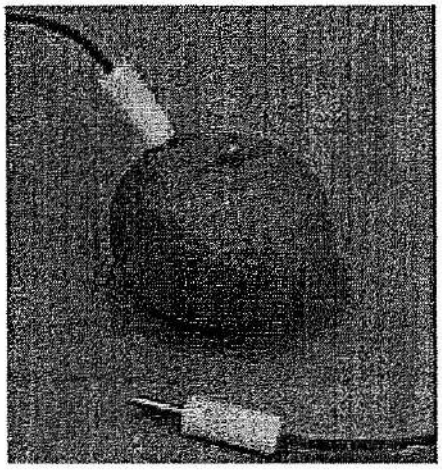

Figure 1.- Detail of the probes

The paper deals with the design of the automatic measurement and recording system, focusing on the optimisation of the system configuration (suitable number and positioning of the probes, required sampling rate, etc.) and the modelling of the relationships between air and pulp temperatures. It also deals with metrological issues that are essential for the commercial use of the system, like the requested frequency of calibration of the probes and the data logger, the procedure for validating the readings, etc. Preliminary experiments are shown where thermal mappings are compared against theoretical models.

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