Pergamon

Radiat. Phys. Chem. Vol. 48, No. 3, pp. 376–377, 1996

PII: S0969-806X(96)00050-3
0969-806X/96 $15.00 + 0.00

DOSIMETRY AND PROCESS CONTROL—SELECTED EXAMPLES WITH PRACTICAL RELEVANCE

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Consumers are concerned about processing food by ionizing radiation. As long as this treatment is generally rejected and the process legally banned, the only remaining problem is the control of the market and the detection of illegally irradiated items. Today, analytical methods are available for any application likely to be exploited commercially; these methods, by and by, are now established in the laboratories of food control authorities and used routinely (Delincée, 1993). Once processing of food by ionizing radiation is permitted the situation mutates completely: irradiated items need to be labelled and official control must verify a treatment within the accepted dose limits. While analytical methods contribute to enforcement of labelling it will still be a long way to go before methods become available to derive the most probable dose of radiation treatment. Furthermore, some legislation in specifying dose ranges or averages for "batches" or even for larger, undefined quantities requires the determination of the type (shape) of statistical data distribution and the estimation of relevant statistical parameters (Ehlermann, 1994b). Analytical identification methods applied to individual samples from the market are unsuitable to render such information. Process control at the irradiation facility together with dosimetry from treatment planning is the sole approach to resolve the problem (Ehlermann, 1994a).

At the irradiation facility always reliable and probative evidence is available about any processed item (Ehlermann, 1993). Such evidence serves to settle disputes with customers about correct treatments in the interest of both the contractor and the operator. Mostly, this evidence is on minimum and maximum dose values as these are the technologically limiting data. From commissioning of facilities additionally extensive dose mapping data for several loading configurations, material and bulk densities and in case of accelerators for several machine parameter settings are documented. On the occasion of certain extra dosimetry or because of customer requirements specific measurements may be conducted.

Such particular requirements are associated with insect disinfestation for quarantine control. It has been proposed to provide dose meters at reference positions outside the fruit containers which are easily readable for inspectors. For the resulting value a clear and reliable link to shape and parameters of the dose distribution inside the containers needs to be established. To contribute to the solution of the problem IAEA has established a Co-ordinated Research Programme "Standardized Methods to Verify Absorbed Dose in Irradiated Fresh and Dried Fruits, Tree Nuts in Trade".

In a first model study readily available plant material (potatoes) was used. Four dose meters were attached to the surface of each individual piece at nearly equidistant positions. Containers were irradiated by 10 MeV-electrons, 50 (90) potatoes were used per container in one-sided (two-sided) irradiations. Dose was set arbitrarily to a range of good sensitivity of the dosimetric film used.

The target question of quarantine treatment is which portion by mass, volume or surface receives a dose below a given limit. To estimate this quantity frequency densitity distributions were determined from dose mapping where each dose meter represented equal amounts of mass, volume or surface. Surprisingly, the resulting distributions were all close to Gaussian shape regardless of one- or double-sided irradiation. This implies that for the given product and geometries placing dose meters at the expected positions of maximum and minimum dose values and averaging the readings would give the best (most probable) estimate of the mean value. A shift of the mean value would be the most critical indicator of any fluctuations during radiation processing. Variations of bulk density can be known in advance from long term experiences and are not expected to vary in an uncontrolled manner. Consequently, expected variations of bulk density together with the previously determined parameters of the Gaussian distribution of dose for a given treatment can be used to estimate the fraction (or probability) of goods not receiving the required minimum dose. Such approach could considerably facilitate the task of health inspectors. Dose meter systems easily readable for inspection purposes are just appearing on the market being adapted to relevant dose ranges.

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