

I.10. DOSIMETRY CONTROL FOR RADIATION PROCESSING – BASIC REQUIREMENTS AND STANDARDS

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Food irradiation is subject of interest worldwide due to the ongoing debate on their safety and nutritional adequacy. Industrial usage of radiation technologies for food processing requires establishment of international system for quality control of processing to guarantee safety of food. As far as main parameter to be measured is absorbed dose, quality control basically depends on the establishment of reliable system for technological dosimetry on every step of the irradiation processing. Therefore such system is subject to all relevant international codes and standards. Bulgaria has a long experience in food irradiation, three irradiation facilities are operational at the moment, this requires establishment of National system for dosimetry control for irradiation processing. Such system would facilitate Bulgarian presence on the international market and would guarantee the rights of the consumers.

Basic international codes and standards for dosimetry control for radiation processing (high doses dosimetry)

All organizations and authorities responsible for the regulation of food irradiation give much concern to the appropriate dosimetry control in their documents. Reliable and accurate control of absorbed dose is in favor of both processors, by guaranteeing productivity and efficiency of procedures, and consumers, by guaranteeing quality and wholesomeness of food products.

Basic document concerning food irradiation is CODEX GENERAL STANDARD FOR IRRADIATED FOODS (CODEX STAN 106-1983, REV.1-2003), published by Codex Alimentarius Commission under joint FAO and WHO. Primary parameter for technology control is absorbed dose and guidance for dosimetry control system such as methodology; dosimetry systems, documentation and required stuff are stated in it.

International Consultative Group on Food Irradiation, under IAEA, WHO and FAO, has been publishing recommendations on food irradiation since 1982. Specific procedures for dosimetry control, applied in different processing, are discussed.

American Society for Testing and Materials (ASTM) by means of subcommittee E10.01 – DOSIMETRY FOR RADIATION PROCESSING has been developing standards for dosimetry of irradiation processing of foods. Up to now six standards for food irradiation have been adopted, some of them have become ISO standards. They establish procedures for dosimetry control as well as the kinds of dosimeters, calibration methods and testing for high dose measurements.

Directive 99/2/EC of European Commission on the approximation of the laws of the Member States concerning foods and food ingredients treated with ionizing radiation in Annex 3 establish methods for dosimetry control for food irradiation.

Although there are certain differences among above mentioned documents, all relevant international bodies agree, that dosimetry control is of much importance to the irradiation technology, and that the establishment of an uniform system would benefit the quality and efficiency of the food processing.

Setting up a dosimetry control for radiation processing

There is international agreement on the basic steps of dosimetry control based on previous experience in radiation processing. Recommended codes of practice include:

- Attestations of irradiation facilities on putting into operation and in case of any change to the irradiation parameters, including absorbed dose map with phantom (preferably water equivalent)
- On putting into industrial operation of every irradiation technology an absorbed dose map, in the particular packaging form, should be prepared to ensure the minimum and maximum absorbed dose required by the specific process
- Routing dosimetry control in specific points should be established to guarantee the quality of the processing. It is recommended to accompany every package with dose indicator to distinguish processed and non processed food

Different dosimeters are used for the control of the radiation processing of foods. The choice of dosimetry system depends on variety of factors including: dose interval for acquiring of technological needs, price, availability and easiness to use. A dosimetry system consists of dosimeter, measurement system, calibration curves and standards and methods to use. Processing dosimeter is a mean for measurement of absorbed dose with specific

composition that changes its properties due to the interaction with ionizing radiation in a way that is simply dependant on the absorbed dose. Depending on the accuracy dosimeters can be primary standard, reference standard, transfer standard and routine dosimeters. Worldwide there are about 20 standard dosimetry systems for laboratory preparation or commercially available. Most commonly use dosimeters for radiation processing of foods are:

Alanine ESR dosemeters for dose interval from 1 to 10^5 Gy measured by ESR spectrometer

- Cellulose acetate for dose interval from 10^3 Gy to 10^6 Gy with UV spectrometer
- Ferro sulfate dosimeters from 20 to $2 \cdot 10^2$ Gy with UV spectrophotometer
- Alanine chlorebensole dosimeters from 10^2 to $2 \cdot 10^6$ Gy with spectrophotometer, oscilloscope and titration
- Radiochromic film dosimeters from 10^2 to 10^5 Gy

All results from the dosimetry control of the radiation processing should be adequately archived in the processing documentation of the irradiation facility and included in the accompanying documents for every lot of processed food for the purposes of legislation. As an inseparable part the min/max and mean absorbed dose should be mentioned.

Every irradiation facility should have competent personal trained to establish procedure dosimetry control

Metrology control of the dosimetry system

Dosimetry control of the process is a part of the quality system of every irradiation facility, so all the means and methods should be certified. Basic requirement to the dosimeter systems is its traceability to international or national standard. Due to these requirements calibration and audit should be done in accredited laboratory within ISO. Such laboratory should be compliant with some author specific requirements such as

- Standard room with controlled interaction with outside ionizing, electric, or electromagnetic fields, along with controlled temperature, pressure and humidity
- Irradiation facility calibrated to specific device to guarantee power of irradiation field within specific circumstances
- Measurement apparatus connected to the measurement parameters and verified with national standard

- Validated procedure for calibration for all dosimetry systems
- Verified system for evaluation of uncertainty of measurement
- Unified system for documentation and personal responsibility

Every lot of dosimeters should be verified and calibrated to ensure the min/max absorbed dose thus ensuring quality of irradiated foods. Standards accepted for different dosimetry systems describe calibration, verification and evaluation procedures in details

Present state of dosimetry control for food processing in Bulgaria

In the past 40 years food irradiation is one of the important technologies in Bulgaria. Some processes, such as:

- Fresh fruits and vegetables irradiation for prolongation of shelf life
- Potatoes, garlic and onion against sprouting
- Herb and spices, teas for desinsection and decontamination
- Pulse, wheat and flour for desinsection
- Dry animal products, fruits and vegetables

Three industrial facilities are constructed in Bulgaria. Along with the experimental facilities they carried out a lot of food products. These days such activity is strongly reduced. Simultaneously with radiation processing, irradiation-processing dosimetry was developed. Nowadays radiochromic, semiconductor, chlorine - benzol and ferro-sulfate dosimeters are in use. Although some attempts to standardize radiation-processing dosimetry were made in the end of the last century, up to now there is no such system in Bulgaria. Only in **Ordinance №6** On the list of foods that may be treated with ionizing radiation and conditions and order of the treatment, some aspects of dosimetry are mentioned in brief, but this is utterly insufficient to guarantee the quality of dosimetry control. One of the main problems is the absence of neither national standard for high doses nor accredited laboratory for calibration and audit of radiation processing dosimetry systems. It is necessary to adopt a standard for the establishment of dosimetry control and main dosimetry systems used in Bulgaria.

As a conclusion it must be stated that the establishment of unified system for dosimetry control of radiation processing of foods would greatly enhance quality and efficiency of irradiation processing guarantee consumers rights for food quality and safety. These problems should be resolved with the efforts of all concerned authorities, radiation processors and food producers. The accumulated in Bulgaria experience in the field of

radiation processing as well as presence of necessary equipment for metrology and calibration could be a good base for qualitative dosimetry control in food processing.

References:

1. ISO/ASTM51204-04(E) Standard Practice for Dosimetry in Gamma Irradiation Facilities for FOOD Processing
2. ISO/ASTM51702-04(E) Standard Practice for Dosimetry in a Gamma Irradiation Facility for Radiation Processing
3. ISO/ASTM51649-2002 Standard Practice for Dosimetry in an Electron Beam Facility for Radiation Processing at Energies Between 300 keV and 25 MeV
4. ISO/ASTM51608-2002 Standard Practice for Dosimetry in an X-Ray (Bremsstrahlung) Facility for Radiation Processing
5. ISO/ASTM51431-2002 Standard Practice for Dosimetry in Electron and bremsstrahlung Irradiation Facilities for FOOD Processing
6. CODEX General Standard for Irradiated Foods, (CODEX STAN 106-1983, Rev. 1-2003)
7. CODEX Recommended International Code of Practice for Radiation Processing of Food, (CAC/RCP 19-1979, Rev. 1-2003)
8. ISPM Guidelines for the Use of Irradiation as a Phytosanitary Measure, (No. 18, IPPC, 2003)
9. European Parliament and Commission Directive 99/2/EC of on the approximation of the laws of the Member States concerning foods and food ingredients treated with ionizing radiation
10. Ministry of Health Ordinance №6 On the list of foods that may be treated with ionizing radiation and conditions and order of the treatment