Foodstuffs – Detection of irradiated food using photostimulated luminescence

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Foodstuffs - Detection of irradiated food using photostimulated luminescence

Produits alimentaires - Détection d'aliments ionisés par photoluminescence
Lebensmittel - Nachweis von bestrahlten Lebensmitteln mit Photostimulierter Lumineszenz

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Foreword

This document EN 13751:2002 has been prepared by Technical Committee CEN/TC 275 “Food analysis - Horizontal methods”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2003, and conflicting national standards shall be withdrawn at the latest by March 2003.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies a method for the detection of irradiated foods using photostimulated luminescence (PSL). The technique described here comprises an initial measurement of PSL intensity which may be used for screening purposes, and a calibration method to determine the PSL sensitivity to assist classification. It is necessary to confirm a positive screening result using calibrated PSL or another standardised (e.g. EN 1784 to EN 1788) or validated method.

The method has been successfully tested in interlaboratory trials using shellfish and herbs, spices and seasonings [1]. From other studies it may be concluded that the method is applicable to a large variety of foods [2], [3], [4].

2 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

2.1 photostimulated luminescence (PSL)
radiation specific phenomenon resulting from energy stored by trapped charge carriers. Release of this stored energy by optical stimulation can result in a detectable luminescence signal.

2.2 PSL intensity
amount of light detected during photostimulation, in photon count rate

2.3 screening PSL or initial PSL
PSL intensity recorded from the sample as received or following preparation

2.4 calibrated PSL
PSL intensity recorded from the test sample following irradiation to a known dose, after initial PSL measurement

2.5 thresholds
values of PSL intensity used for classification. In screening mode, two thresholds, a lower threshold \( T_1 \) and an upper threshold \( T_2 \) are used to classify the sample
2.6 negative PSL result
PSL intensity below the lower threshold (less than \( T_1 \))

2.7 intermediate PSL result
PSL intensity between the upper and the lower threshold (greater than or equal to \( T_1 \), less than or equal to \( T_2 \))

2.8 positive PSL result
PSL intensity above the upper threshold (greater than \( T_2 \))

2.9 dark count
photons count rate from the photomultiplier with an empty chamber in the absence of stimulation

2.10 light count
photons count rate with a reference light source (e.g. \( ^{14}\text{C} \) loaded scintillant, or equivalent) in the sample chamber

2.11 empty chamber run
PSL intensity measured from an empty sample chamber to ensure absence of contamination of the chamber

3 Principle

3.1 General
Mineral debris, typically silicates or bioinorganic materials such as calcite which originate from shells or exoskeletons, or hydroxyapatite from bones or teeth, can be found on most foods. These materials store energy in charge carriers trapped at structural, interstitial or impurity sites, when exposed to ionising radiation. Excitation spectroscopy has shown that optical stimulation of minerals releases charge carriers [5], [6], [7]. It has subsequently been shown that the same spectra can be obtained from whole herb and spice samples and other foods using photostimulation [2], [8], [9]. PSL measurements do not destroy the sample, therefore whole samples, or other mixtures of organic and inorganic material, can be measured repeatedly. PSL signals, however, decrease if the same sample is measured repeatedly.

The methodology comprises screening (initial) PSL measurements to establish the status of the sample (see 2.3) and an optional second measurement following a calibration radiation dose to determine the PSL sensitivity of the sample (see 2.4).

3.2 Screening PSL
For screening (see 2.3) the signal levels are compared with two thresholds (see 2.5). The majority of irradiated samples produce a strong signal above the upper threshold level. Signals below the lower threshold suggest that the sample has not been irradiated. Signal levels between the two thresholds, intermediate signals, show that further investigations are necessary. The use of thresholds produces an effective screening method which can also be backed up by calibration, by TL as described in EN 1788 or another validated method, e.g. [3], [4], [8].

3.3 Calibrated PSL
For calibration, the sample is exposed to a defined radiation dose after the initial PSL measurement, and then re-measured. Irradiated samples show only a small increase in PSL after this radiation exposure, whereas unirradiated samples usually show a substantial increase in PSL signal after irradiation.