



**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB 14883.10-2016

**National food safety standard - Examination of Radioactive
Materials for Foods - Determination of Cesium-137**

食品安全国家标准 食品中放射性物质铯-137的测定

(English Translation)

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1 Scope

This Standard is applicable to the determination of cesium-137 (^{137}Cs) in various foods.

Method-1 -- gamma Spectrometry

2 Principle

Directly, or after certain pre-treatment, load fresh food samples into a certain shape and volume of sample box. On gamma spectrometer, measure the gamma-ray characteristic

peak full energy peak net area of ^{137}Cs in the sample at 661.6 keV. Compare it with a standard radioactive source whose activity is already known. Calculate the concentration of ^{137}Cs radioactivity. When cesium-134 (^{134}Cs) exists in the sample, this method shall be applied to the determination of ^{137}Cs .

3 Reagents and Materials

^{137}Cs radioactive standard solution: specific activity is around 1,000 Bq/mL; it shall be calibrated by a national statutory metrology department; it shall have an inspection certificate signed by a legally recognized organization.

4.1 Low Background gamma Spectrometer System

Low background gamma spectrometer system shall satisfy the following requirements:

- a) Detector: coaxial high-purity germanium or germanium (lithium) detector. In terms of ^{60}Co 1332.5 keV gamma-ray full energy peak, its energy resolution shall be less than 3 keV; its relative efficiency shall be higher than 15%.
- b) Shield: the primary shield shall be multi-layer material heavy metal shield,

5.1.1 Energy scale

In accordance with energy scale, use gamma radioactive source (4.4) to conduct energy scale of the low background gamma spectrometer system (4.1). Record the characteristic gamma-ray energy of the scale source, and corresponding full energy peak location. Through computer processing, or drawing on a cartesian coordinate paper, or conducting the least square fitting of the data, a graph of the relations between energy and the location may be obtained.

5.1.2 Full energy peak detection efficiency scale

Measure ^{137}Cs standard radioactive source. In order to reduce system errors, the net area of the full energy peak being measured shall at least be more than 100,000 counts.

In accordance with Formula (1), calculate its detection efficiency at 661.6 keV gamma-ray full energy peak.

Where,

E---detection efficiency of ^{137}Cs standard radioactive source at 661.6 keV gamma-ray full energy peak;

N---net area of 661.6 keV gamma-ray full energy peak, expressed in (count);

A ---activity of ^{137}Cs standard radioactive source, expressed in (Bq);

T ---measured time of ^{137}Cs standard radioactive source, expressed in (s);

B---branch ratio of ^{137}Cs 661.6 keV gamma-ray, 84.62%.

5.2 Sampling

Sampling shall comply with the stipulations in GB 14883.1.

5.3 Preparation of Sample for Measurement

5.3.1

Grain sample

Take 500 g of sample, then, evenly spread it in an enameled plate or a stainless-steel plate. Place it in the oven, at around 70 °C, dry it for around 5 h.

Then, weigh it; calculate the dry mass/fresh mass ratio. In terms of granular grain, dry it, then, directly place it into a sample box, which is already cleaned on the outside and the inside; tamp it. In terms of finely powdered grain, use a sampler to press it, so that the height of the sample is the same as the height of ^{137}Cs standard radioactive source.

Record the dry sample mass and the height of the sample to be determined; calculate its apparent density.

5.3.2

Vegetable sample

Take around 3 kg of sample; remove the inedible part. Wash

E---same as Formula (1);

F---total correction factor of measurement efficiency, %, please refer to Appendix A;

please refer to GB/T 16145 for more accurate calculation methods;

B---branch ratio of ^{137}Cs 661.6 keV gamma-ray, 84.62%;

W---equivalent fresh sample mass of the sample being measured, expressed in (kg) or (L);

λ --- ^{137}Cs 's disintegration constant, expressed in (a⁻¹); $\lambda = 0.693/T_0$, T_0 is ^{137}Cs ' radioactive half-life, 30 a;

t---time interval from sampling to measurement, expressed in (a).

7 Others

The lower detection limit of ^{137}Cs radioactivity may be calculated in accordance with Appendix B and the practical situation.

Method-2 -- Ammonium Phosphomolybdate Method

8 Principle

Use nitro-hydrochloride to leach food ash. Through adsorption separation of ammonium phosphomolybdate, under citric acid masking, use iodine bismuth salt to deposit and purify cesium. Use low background beta-ray meter to measure beta radioactivity of ^{137}Cs .

9 Reagents and Materials

Unless it is otherwise stipulated, all reagents used in this method shall be analytically pure. Water shall be Grade-1 water stipulated in GB/T 6682.

9.1 Reagents

9.1.1

Diammonium hydrogen phosphate $[(\text{NH}_4)_2\text{HPO}_4]$.

9.1.2

Ammonium nitrate (NH_4NO_3) .

9.1.3

Ammonium molybdate $[(\text{NH}_4)_6\text{Mo}_7\text{O}_{24}\cdot 4\text{H}_2\text{O}]$.

9.1.4

Bismuth trioxide (Bi_2O_3) .

9.3.1 ^{137}Cs standard solution: around 1×10^3 disintegrations / (min-mL), contains 0.1 mol/L hydrochloric acid solution of 0.1 mgCs+/mL.

9.3.2 Cesium carrier solution (10 mgCs+/mL): weigh-take 12.67 g of cesium chloride, then, place it in a small beaker. Add water to dissolve it, then, add 3 drops of concentrated hydrochloric acid. Quantitatively transfer it into 1 L volumetric flask; use water to dilute to the scale. Calibration may use one of the following two methods:

a) Calibration method 1 -- cesium perchlorate method: accurately absorb 4.00 mL of cesium carrier solution, then, place it in a 125 mL conical flask. Add 1 mL of nitric acid and 5 mL of perchloric acid. Evaporate it, till it emits white smoke for a few minutes. Take it down, then, cool it down to the room temperature. Add

15 mL of absolute ethanol, shake it up. Then, in ice bath, cool it down for a few minutes. Extract and filter the sediment in G4 sand core glass crucible, which is already weighed. Use 10 mL of absolute ethanol to rinse it once, then, at

105 °C, dry it for 15 min. Cool it down in the dryer, then, weigh it.

b) Calibration method 2 -- tetraphenylboron-cesium method: take 2.00 mL of cesium carrier solution, then, place it in a 100 mL beaker. Add 20 mL of water and 1 mL of 6 mol/L acetic