



X-RAY FLUORESCENCE

Analysis of Bone Content in Mechanically Separated Raw Meat

Lab Report 183

Introduction

When it comes to food safety and quality, raw meat and poultry are among the highest-risk categories. Frequent recalls, government regulations, and safety protocols impact major brands. To meet stricter requirements, protect consumers' health, and maintain brand reputation, meat and poultry manufacturers must ensure product safety and quality at every stage—from farms and processing facilities to distribution centers and stores. Suitable analytical solutions play an inevitable role in the quality assurance process.

An innovative analytical solution for elemental analysis in the food industry is X-ray Fluorescence (XRF) spectrometry. It provides fast and accurate results after minimal sample

preparation. The S2 PUMA - Series 2, a benchtop Energy Dispersive XRF (EDXRF) spectrometer, enables easy and low-cost analysis of minerals, bone percentage, added phosphates, and heavy element contaminants in raw meat and poultry. Unlike alternative wet-chemistry methods, such as titration or inductively coupled plasma mass spectrometry (ICP-MS), XRF doesn't require skilled operators or expensive, hazardous chemicals.

This lab report demonstrates the S2 PUMA's performance in calcium analysis—a tracer for residual bone content in mechanically separated meat (MSM). Meeting the maximum calcium content regulation set by the Food Safety and Inspection Service Agency of the US Department of Agriculture (USDA) is a constant challenge for meat processing plants, which must maximize yield cost-effectively.

Bone Content: Regulatory Requirements

In the United States, the Title 9 of the US Code of Federal Regulations (CFR) defines the maximum bone content as a function of the calcium (Ca) content. For mechanically separated poultry meat (9 CFR Part 381.173) the Ca content shall not exceed 0.235% when made from mature chicken or turkey or 0.175% when made from other poultry. For MSM from other species like pork, lamb, and beef (9 CFR Part 319.5) the limit is 0.75 % Ca. In Europe, the calcium content of all MSM shall not exceed 0.1% according to Article 4 and Annex IV of Commission Regulation (EC) No 2074/2005.

The Meat Elemental Analyzer: S2 PUMA

The S2 PUMA Series 2, a versatile, high-performance benchtop EDXRF spectrometer, is an excellent solution for process and quality control in the food industry. The optimized beam path, the 50-Watt power X-ray tube, and the HighSense™ Silicon Drift Detector (SDD) ensure short time-to-results in combination with outstanding analytical performance (Figure 1). Bruker's unique multi-layer SampleCare™ concept protects vital system components from contamination, including accidental sample spills or breakages. This guarantees high system uptime and easy maintenance.

The intuitive and powerful software SPECTRA.ELEMENTS allows users to operate the device after minimal introduction. And with the TouchControl™ interface routine analysis can be performed without an external PC.



Analytical Approach and Sample Preparation

The bone percentage in MSM, including ground raw meat products, is directly related to the Ca content. The sample preparation to measure the Ca content in such materials with XRF is easy and fast. Ten grams (10 g) are weighed into a disposable plastic cup with a thin polymer foil at the bottom. For this report we used 4 µm Prolene® but other foils can also be used. The cup with the sample material is loaded directly into the measurement chamber when using a S2 PUMA with manual loader (Figure 1). A system equipped with an XY-Autochanger allows for the loading of 22 samples, which are handled automatically by a grabber (Figure 2). The measurement is started with the push of a button. Preparing the sample and starting the measurement takes about 1 min.



Figure 1 Preparation and loading of liquid and slurry samples, such as ground meat.



Figure 2
S2 PUMA with
XY-Autochanger.

Calibration Details

A set of 40 secondary raw meat standards, with concentration levels of Ca between 0 – 1 wt.%, were used to calibrate the S2 PUMA. Suitable statistics are achieved with a counting time of 200 s. The analytical conditions are summarized in Table 1. The spectra for the Ca KA line are displayed in Figure 3. The peak and background positions were defined by integration and lower envelope, respectively.

Table 1

Measurement conditions.

Elemental Line	Voltage	Current	Filter	Counting time	Sample Rotation	Mode
Ca KA	20 kV	Automatic	none	200 s	On	Air

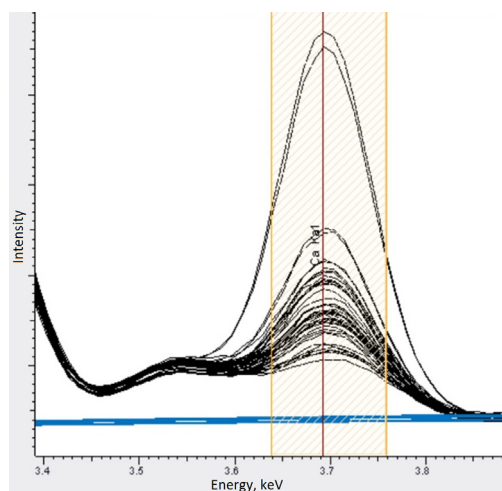


Figure 3

Ca KA1 peaks of the secondary standards. The integration range is marked by an orange shaded area; the background (lower envelope) is displayed by blue lines.

Analytical Precision

For the precision test, ten preparations were measured. Each time, a new cup was loaded using fresh raw meat material of the same sample. The low standard deviation of the results (Table 2) confirms the suitability of the sample preparation and demonstrates the outstanding stability of the S2 PUMA for such applications.

Table 2

Analytical repeatability test using a fresh raw meat sample for each measurement.

Measurement #	Ca [wt.%]
Rep-1	0.24
Rep-2	0.23
Rep-3	0.24
Rep-4	0.23
Rep-5	0.26
Rep-6	0.26
Rep-7	0.23
Rep-8	0.24
Rep-9	0.23
Rep-10	0.23
Average	0.24
Abs Std. Dev.	0.01
Rel. Std. Dev.	5.0%

Conclusion

This lab report highlights the excellent performance of the S2 PUMA for the analysis of bone percentage in mechanically separated raw meat and poultry. With the S2 PUMA, bone content monitoring becomes a quick and easy task. The high analytical precision enables tight quality monitoring and process optimization. Hence, regulatory thresholds can be met closely without removing more bones than necessary – saving money!

The S2 PUMA is a versatile, sturdy, and easy to use elemental analyzer which uses state-of-the-art XRF technology and is designed for industrial environments. Apart from analyzing the Ca concentration in MSM, other elements like Na, Mg, P, S, K, Ca, Zn, Mn, Cu, and Fe can also be measured and quantified in many (processed) meat sample types and products with the S2 PUMA.

Bruker AXS

info.baxs@bruker.com

[bruker.com](https://www.bruker.com)

Worldwide offices

bruker.com/baxs-offices



Online information

bruker.com/s2puma

