



UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Bureau
International des
Poids et
Mesures



Building Capacity for the Measurement of Contaminants in Durian Exports

TISTR has enacted a new PT scheme for basic yellow 2 dye and cadmium in durian fruit, which has improved the capability of Thai food testing laboratories

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The Challenge

Thailand is one of the world's leading exporters of durian fruit, generating significant economic value for the country. However, recent incidents involving contamination of Basic Yellow 2 (BY2) in fresh durian and frozen durian for export have raised serious concerns regarding food safety and international trade confidence. BY2 is a prohibited synthetic dye that may pose potential health risks to consumers and is not permitted for use in food products. Such contamination may result either from the intentional use of the dye to enhance or modify the colour of durian products to meet market preferences, or from unintentional migration from packaging materials, such as durian cartons or boxes.

In addition, chemical contamination of heavy metals—especially cadmium—is also an important issue in durian export control. Therefore, strict monitoring and accurate quantification of BY2 and cadmium are required to meet regulatory limits and maintain consumer safety. The contamination issue affects the entire durian supply chain, from farmers who grow and harvest the fruit to packing houses, exporters, and regulatory authorities. In addition, many importing countries have implemented stricter inspection and surveillance measures, which may impact Thailand's export reputation and market competitiveness.

The competence of food product and safety testing laboratories is critical to the quality infrastructure system that enables reliable, metrologically sound analytical results for monitoring and controlling contamination in durian and durian-based products. It is vital that testing laboratories operate with metrologically traceable, validated analytical methods, qualified personnel, and internationally recognized quality systems to ensure trusted, confident detection and measurement of BY2 and cadmium contamination. To ensure the validity of the result, a proficiency testing (PT) program further enhances confidence in laboratory competence.

Currently, there is no internationally standardized analytical method for determining BY2 in a durian matrix. Testing laboratories are also required to perform method validation to demonstrate the fitness for purpose and reliability of their analytical methods, in accordance with the recommended Chinese standard no. BJS 202204, which is the determination of 11 industrial dyes, including auramine O (Basic yellow 2), in soy products. In addition, external quality control protocols and proficiency testing (PT) schemes are recommended as essential components for ensuring confidence in test results and maintaining laboratory competence.

The Solution

To support laboratory performance evaluation and improve analytical reliability, a proficiency testing (PT) program for BY2 and Cadmium was organized and conducted in January 2026 through May 2026. The program included appropriate statistical approaches for participant evaluation and technical performance assessment to ensure the comparability and reliability of analytical results among participating laboratories. The effort also included a technical seminar to promote the exchange of knowledge, experiences, and best practices among regulators, experts, laboratories, interested participants, and other stakeholders involved in the durian export supply chain.

The proficiency testing (PT) program was conducted in accordance with ISO/IEC 17043, including program planning, sample preparation, homogeneity and stability study, and result reporting for performance evaluation. Fresh durian samples were separated into meat and shell, freeze-dried, processed, and bottled in amber glass bottles to prepare representative PT materials. The evaluation of PT material homogeneity and stability, as well as participant performance, was conducted using appropriate statistical methods in accordance with ISO 13528:2022 to ensure reliable interpretation and comparability of laboratory results. Participants were informed of the program schedule, technical instructions, reporting requirements, and deadlines for submission of analytical results.

The assigned value for BY2 was determined from participants' results using a consensus approach in accordance with ISO 13528:2022.¹ At present, an assigned value with metrological traceability for the PT materials cannot be established, as no primary standards or reference materials are available for BY2 analysis. While a consensus-assigned value provides a practical means of assessing laboratory performance, it is inherently limited in terms of metrological traceability compared with a reference value established through a traceable measurement system. This limitation highlights the need for the development of appropriate reference materials and metrologically traceable measurement methods for BY2 to support the reliability and international comparability of future PT schemes.

For cadmium (Cd), the assigned value was derived from a reference value provided by the National Institute of Metrology Thailand (NIMT), with metrological traceability through the National Institute of Standards and Technology (NIST) SRM 3108, using an Isotope-dilution Inductively Coupled Plasma Mass Spectrometer (isotope-dilution ICP-MS) is a high-sensitivity elemental analysis instrument that measures trace and ultratrace elements.

A Quantifiable Impact

The PT scheme showed that the majority of technical analyses used for BY2 analysis (89 %) were based on liquid chromatography with tandem mass spectrometry (LC-MS/MS) which enables improved analyte identification and accurate quantification. The analytical technique

¹ ISO 13528:2022. Statistical methods for use in proficiency testing by interlaboratory comparison. (Algorithm A)

also complied with the recommended Chinese standard method BJS202204.² The participants measuring BY2 in both pulp and shell matrices showed a satisfactory rate of 89 %. This reflects the effectiveness of these techniques in handling the complex durian matrix. The high consistency in both accuracy (z-score) and internal precision (Cochran's test) confirms that the analytical methods used by this group for BY2 determination are clearly standardized and harmonized.

For the cadmium analysis, a lower proportion of satisfactory z-scores (71 %) was observed. The participating laboratory used international reference test methods, such as AOAC 999.10³ and AOAC 2015.01.⁴ Interestingly, 83 % of participants used the high-sensitivity ICP-MS method for analysis. This discrepancy indicates that the laboratories can achieve excellent within-laboratory precision (as demonstrated by Cochran's test), but achieving absolute analytical accuracy remains a technical challenge. The observed bias may come from systematic errors such as incomplete sample digestion or insufficient matrix-effect compensation during trace-level detection.

A Root Cause Analysis (RCA) was conducted for laboratories with unsatisfactory results ($|z| \geq 3.0$ or $C_{\text{calc}} \geq C_{\text{crit}}$), with a summary of results as follows:

- Basic Yellow 2 (BY2): focusing on extraction efficiency, matrix effect compensation, clean-up procedures, and calibration curve linearity. Matrix-matched calibration is strongly encouraged to improve analytical accuracy and reduce matrix interference from durian pulp and shell.
- Cadmium (Cd): focusing on digestion efficiency, contamination control during sample preparation, instrumental stability, and calibration performance. Laboratories should also verify the effectiveness of microwave digestion and ensure appropriate quality control throughout ICP-based analysis.

Additionally, all participants should re-verify their measurement uncertainty budgets to ensure they are technically justified and adequately cover the analytical complexities of the durian matrix. The RCA is a critical step to ensure that all participants in the PT schemes can work towards measurement comparability, capacity building, and achieve laboratory competence. Furthermore, this improved capability ultimately underpins the Thai NQI and ensures the production of high-quality durian for export.

The laboratory data, including test results, methods used, and evaluation outcomes, provide important evidence for assessing laboratory competence, analytical capability, and the reliability of testing results for BY2 and cadmium levels in durian and durian-based products. These approaches support the reliability, comparability, and international acceptance of analytical results generated by the participating laboratories.

² BJS 202204:2022. Determination of 11 industrial dyes, including auramine O in soybean products (English)

³ AOAC Official Method 999.10-2005, Lead, Cadmium, Zinc, Copper, and Iron in Foods

⁴ AOAC Official Method 2015.01-2015, Heavy Metals in Food

Overall, the project demonstrated that applying metrological approaches and principles is vital to ensuring the reliability and accuracy of analytical testing for food safety and quality control. This includes proficiency testing schemes, reference value assignment, metrological traceability, quality assurance, and appropriate statistical evaluation techniques. These approaches help build confidence in laboratory results, support regulatory decision-making, strengthen the national quality infrastructure, and ultimately enhance international confidence in Thai durian exports.

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