



UNITED NATIONS  
INDUSTRIAL DEVELOPMENT ORGANIZATION

Bureau  
International des  
Poids et  
Mesures



# Promoting Competitiveness in Colombian Aquaculture: Metrological Traceability for the Control of Inorganic Contaminants in Tilapia

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INM develops proficiency testing, reference material, and training services for measuring lead, cadmium, and mercury in fish and other foodstuffs, with support from PTB and UNIDO

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## The Challenge

Although Colombia's aquaculture sector represents a relatively small share of GDP (0.31 % in 2024), it has experienced strong growth in recent years (9.7 % in 2023 and 9.8 % in 2024);<sup>1</sup> within this sector, red tilapia production—mainly concentrated in the Huila region—stands out, accounting for around 85 % of exports, with the United States as the primary destination for fresh tilapia fillets.<sup>2</sup> In the first half of 2025 alone, tilapia was the most-exported aquaculture product, with exports totaling 17 130 tons valued at over USD 134 million, consolidating its position in international markets due to its freshness and sustainable production.<sup>3</sup> National sanitary requirements are established by the Ministry of Health under Resolution 122 of 2012,<sup>4</sup> while international standards are set by the Codex Alimentarius; both establish maximum limits for toxic inorganic contaminants such as lead, cadmium, and mercury. To support the sector's growth, since 2018, the National Metrology Institute (INM) has engaged with producers and identified the need to develop Certified Reference Materials (CRMs) for use in detecting and validating contaminant measurements in tilapia, given the absence of such tools in the Colombian market.

## The Solution

In 2018, the INM joined a regional project led by Germany's National Metrology Institute (PTB) to strengthen technical capabilities for measuring contaminants in fish, while also conducting a metrological gap analysis with tilapia producers in the Betania reservoir (Huila region) to identify service needs and metrological traceability challenges.<sup>5</sup> As a result, in 2020, the INM developed its first CRMs for mercury and methylmercury in fishmeal, marking a key milestone that supported method validation, measurement reliability, and metrological traceability. Later, in 2021, the INM organized a Proficiency Test (PT) to determine mercury in fish, specifically in fish meal, to evaluate the performance of participating laboratories in this

<sup>1</sup> Departamento Administrativo Nacional de Estadística (DANE). 2026. Cuentas Nacionales: Producto Interno Bruto (PIB) 2024pr. <https://www.dane.gov.co>

<sup>2</sup> ENREDIJO. 2026. Exportación de Tilapia: El Huila Resiste Golpe Arancelario. <https://noticias.enredijo.com/exportacion-tilapia-huila-2025/>

<sup>3</sup> AUNAP. 2025. Noticias AUNAP Colombia incrementa exportaciones pesqueras en un 52% durante el primer semestre de 2025. <https://aunap.gov.co/colombia-incremesemestre-de-2025/#:~:text=Tilapia%2C%20principal%20impulsor%20de%20las,emblem%C3%A1tico%20de%20la%20acuicultura%20colombiana>

<sup>4</sup> Ministerio de Salud y Protección Social. Resolución 122 de 2012. <https://www.minsalud.gov.co/sites/rid/Lists/BibliotecaDigital/RIDE/DE/DIJ/Resolucion-122-de-2012.pdf>

<sup>5</sup> Instituto Nacional de Metrología (INM) y Organización de las Naciones Unidas para el Desarrollo Industrial (ONUDI). 2023. Brechas metrológicas de la cadena productiva de la tilapia en el departamento del Huila. Bogotá, Colombia.

measurement and identify opportunities to improve their analytical capabilities. Five laboratories participated in this proficiency test, of which only one had unsatisfactory results. In addition, with support from international cooperation with UNIDO, the INM expanded its metrological gap analysis in 2021 to include additional companies and laboratories, leading to the 2024 launch of a CRM for method validation to detect lead, cadmium, and mercury in fish muscle, in compliance with national regulations (see **Figure 1**). It is also noted that this CRM can be used in the determination of the levels of lead, cadmium, and mercury in other foods, such as rice, fruits, and vegetables, for which regulations regarding these contaminants are in place. This process also revealed the need for technical training, prompting the INM, with support from UNIDO, to conduct outreach and training activities nationwide and to identify potential future CRM producers within the Colombian Metrology Network. As part of the Colombian Metrology Network, the INM drafted a metrological traceability guide for contaminant measurements in fish to support testing laboratories nationwide.

## **A Quantifiable Impact**

The metrological tools designed by INM have played a key role in ensuring reliable results for detecting contaminants in tilapia, a critical product in Colombia's aquaculture value chain, which generates over 257 000 direct and indirect jobs, while also supporting the development of new measurement capabilities in testing laboratories.<sup>6</sup> Without the creation of these metrological capacities at the INM and the transfer of measurement methods to laboratories, it would not have been possible to meet national technical regulatory requirements, potentially restricting domestic tilapia sales and losing access to the United States market.

The CRM for detecting toxic elements such as lead, cadmium, and mercury in fish muscle (tilapia) represents an innovation for the sector as a whole, as this CRM is suitable for monitoring the quality of fishery and aquaculture products by complying with the requirements of Resolution 122 of 2012, a product that was not previously available in the country. Furthermore, this CRM has generated cost savings for the sector, as the INM's CRM is 36 times cheaper than products imported from countries such as Mexico, Canada, and the United States.<sup>7</sup> Moreover, the continuous delivery of these testing and measurement services over the years demonstrates the consolidation of technical expertise and the sustainable strengthening of national metrology capacity in food safety technologies while addressing regulatory demands to sustain development.

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<sup>6</sup> AUNAP. 2024. Cadena de valor de la acuicultura y avance en caracterización de granjas en el territorio nacional. <https://www.aunap.gov.co/documentos/comunicaciones/banner/Encuentro-de-extension-agropecuaria-y-agronegocios-sostenibles.pdf>

<sup>7</sup> Organización de las Naciones Unidas para el Desarrollo Industrial (ONUDI). 2024. Reporte de avance No. 8: Fortalecimiento de la calidad y la capacidad de cumplimiento de las normas de las cadenas de valor de la acuicultura de camarón y tilapia en Colombia para facilitar el acceso al mercado – Programa Global de Acceso a Mercados (GMAP) Colombia. Bogotá, Colombia.



(a)

(b)

**Figure 1.** (a) INM Certified Reference Materials (CRMs) for Contaminants (Cd, Hg, and Pb) in Tilapia. (b) Preparation of a single CRM unit consisting of 15 g of freeze-dried, ground (to 300 mm) tilapia tissue.

Additionally, the development of a metrological traceability guide facilitated knowledge sharing and scientific exchange with companies and laboratories, strengthening technical expertise and accelerating laboratory accreditation in this field of measurement. In fact, one of the main outcomes of INM's service provision to the aquaculture sector is that Colombia now has four ISO/IEC 17025-accredited laboratories for measuring mercury in fish and one accredited laboratory for measuring cadmium and lead in fish. Likewise, among laboratories that measure heavy metals (cadmium, mercury, lead, and arsenic) in food, 10 are accredited. It should be noted that INM's capabilities and technical expertise remain relevant today.

**Acknowledgments.** This work was made possible by the Instituto Nacional de Metrología (INM) of Colombia and the cooperation project “Global Market Access” (GMAP) aimed at the country's tilapia and shrimp supply chains, implemented by the United Nations Industrial Development Organization (UNIDO).

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