Online Training Curriculum

Confirmation Methods for Food contaminants

Principles of Lateral Flow Devices

Application to food contaminants

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Overview

Main applications

A lateral flow device (LFD), also known as Rapid Diagnostic Test (RDT), is a simple to use diagnostic device used to confirm the presence or absence of a target analyte, such as contaminants in water supplies, foodstuffs, or animal feeds but also pathogens or biomarkers. LFD has been developed as a single-step test that includes a negative control line along with the sample lines on the same strip. These devices allow to detect various analytes in only a few minutes and is based on an antigen-antibody reaction like ELISA assays. The most commonly known type of lateral flow rapid test strip is the pregnancy test.

These tests are designed to be performed outside the laboratory at the site of inspection or Point-of-care (POC). Results are expected to be obtained within a short time (less than 10 minutes), with the help of simple portable devices or even without using any instrument or readers. Like ELISA assays, there are mostly used for allergens [1; 2; 3] or mycotoxins/phycotoxins detection [4;5] but their low development costs and ease of production have resulted in the expansion of applications, like pesticides [6], veterinary drugs [7] or microbial toxins [4] detection, across multiple test-sites where rapid tests are required. LFD are now widely used as routine tools at the POC as part of an early-stage detection protocol, but positive results always need to be confirmed by analytical methods like LC or GC-MS.

LFDs are versatile enough to be developed to detect target analytes in food matrices including:

- Drinks (including milk and water)
- Food (grains, etc.)
- Animal feed,
- But also blood, serum, saliva, urine, etc…

However, their applications in the field is limited due to numerous problems associated with the sensitivity and reliability in different matrices.

Advantages and disadvantages

Lateral flow technology is well-suited to the food safety and environmental testing areas for the following reasons [8]:

- Easy to use, can be performed by untrained personal,
- Fast results,
- Suitable for on-site analysis,
- Highly specific and cost-effective,
- Flexible – Qualitative, Semi-Quantitative and Quantitative,
- Flexible and adaptable to different testing environments,
- Multiplexing capabilities,
- Robust: The tests can be stored at ambient temperature and have a multi-year shelf life,
- No laboratory equipment required,
- No hazardous materials contained,

However, this technology also has flaws that need to be understood and integrated from a risk analysis perspective:

- Limited sensitivity (low LOD/LOQ),
- Limited reproducibility,
- Limited precision du to inaccurate sample volume (if pipettes are not available on site)
- Qualitative or semi-quantitative. If quantitative results are required, a reader will be mandatory in most cases (requirement equipment),
- Sample treatment is needed for non liquid samples,
- Unfit for a lot of food matrices.

Troubleshooting

The use of lateral flow devices (LFDs) to identify allergens has rapidly expanded, but the best practices for use of these devices are still developing.

A major problem in LFD analysis are false negative results due to high allergen concentrations – known as overload effect or hook effect. High amounts of an analyte lead to an imbalance between the analyte and the antibody used, thus preventing the formation of the necessary sandwich complexes. Consequently, the formation of the test band is prevented, and false negative results could be inferred.

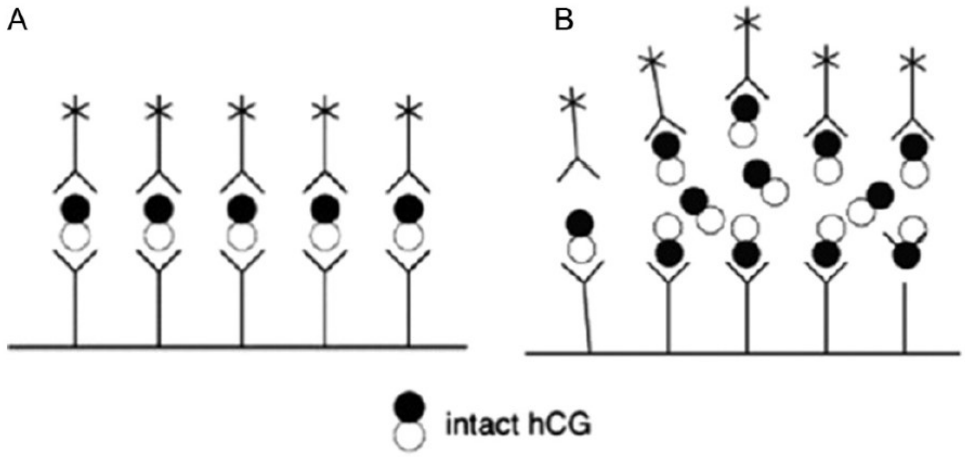

Figure 1: Representation of the "Hook effect" and explanation of the absence of color development at the detection line [9].

To solve this problem, some LFD manufacturers developed rapid test strips that have an additional band, the so-called hook line. The hook line makes the overload effect visible. The attenuation or absence of the hook line indicates a very high content of allergen in the sample. This allows high concentrations of the analyte to be detected and false negative results to be identified. It is all the more important to be wary of this effect as it only occurs with highly contaminated samples, and therefore samples that pose the most risk to consumers.

Table 1: Troubleshooting of LFD testing

Challenge	**Possible cause**
False positive signals	Potential contamination of extraction buffer
	No respect of time exposure
False negative signals	Sample is too viscous
	Particules stop sample migration
	LFD issues
	Hook effect

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