A Unique Strip Test to Detect Pesticides in Drinking Water, Fruits, and Vegetables

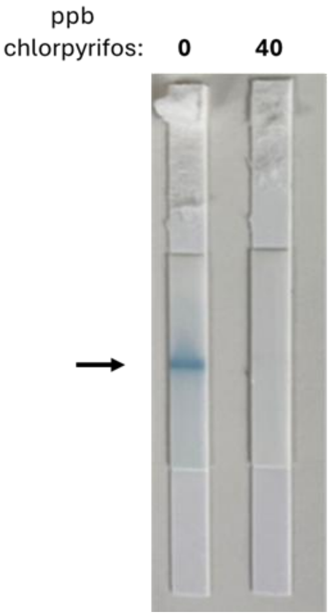

Figure 1. Visual detection of chlorpyrifos inhibition of acetylcholinesterase using the Attogene Acetylcholinesterase Inhibition Strip Test. Water samples containing 0 ppb and 40 ppb chlorpyrifos were tested in the assay. Both samples were treated with Activator Solution to attain maximum test sensitivity. A blue colored line appears at the test line (indicated by the arrow) for the 0 ppb sample, while 40 ppb oxonated chlorpyrifos abolishes the color intensity of the test line.

Introduction:

Organophosphate and carbamate pesticides have played a central role in modern agriculture, shaping global food production since the mid-20th century. Shortly after their synthesis, it was realized that organophosphates have potent effects on insects. Carbamates were developed from naturally occurring plant alkaloids and are valued for their broad-spectrum insecticidal activity and relatively rapid environmental degradation. Both pesticide classes act primarily by disrupting the enzyme acetylcholinesterase (AChE), which is essential for proper nerve function. Organophosphates irreversibly phosphorylate the active site of AChE, leading to the accumulation of acetylcholine at synapses and continuous nerve stimulation. Carbamates act through a similar mechanism but form reversible carbamylated bonds, resulting in shorter-lived inhibition. This shared mode of action explains their effectiveness against a wide range of insect pests but also underlies their potential toxicity to humans and other non-target organisms.

Human exposure to potential pesticide residues in food is a key public health concern because these compounds can be toxic to humans. To reduce this toxicity, organophosphate insecticides are produced as sulfur-containing pro-insecticides known as phosphorothioates, which are less toxic to humans but are rapidly metabolized to the active form in insects. The detection of phosphorothioate precursors requires an oxidative chemical conversion (Activation) to generate active organophosphate pesticides. Ingestion of contaminated produce or water can lead to mild, transient symptoms such as headache or nausea in cases of low-level exposure, while higher exposures can cause more serious cholinergic symptoms. While these pesticides are regulated to minimize risk, their presence in food remains an area of active monitoring and scientific scrutiny.

A wide variety of fruits and vegetables are commonly treated with these pesticides, including malathion and chlorpyrifos. Citrus crops such as oranges, lemons, and grapefruit are primary recipients, as these chemicals are heavily utilized to combat the Mediterranean fruit fly and scale insects. Stone fruits like cherries, peaches, and apricots, along with small fruits such as blueberries and strawberries, often see applications to prevent infestations from aphids and fruit flies. Regarding vegetables, malathion is a staple for protecting leafy greens and cruciferous crops, including lettuce, broccoli, cauliflower, and cabbage. It is also frequently applied to root vegetables like potatoes and onions, as well as tomatoes and peppers in both field and greenhouse settings. Malathion remains one of the most frequently used synthetic pesticides in modern agriculture, and its prevalence on these common produce items underscores the importance of monitoring to ensure residual levels remain safe for consumption.

While organically grown crops are typically grown without the use of these synthetic pesticides, it is possible for conventionally grown crops to carry pesticide residues. Because these pesticides are used to maintain high-yield farming, it is possible to detect these residues on produce found in the marketplace. Beyond residues in food, the movement of pesticides into surface and ground waters poses a significant risk to aquatic ecosystems. Because organophosphates and carbamates are often applied in large quantities, they can enter surface water through agricultural runoff or leach into groundwater, potentially contaminating local wells and drinking water supplies. These residues are highly toxic to non-target aquatic life, including fish and beneficial insects, disrupting the natural balance of these habitats.

Monitoring surface and ground water is therefore essential, as environmental persistence can lead to long-term exposure for both wildlife and human communities relying on these water sources.

Monitoring these residues is essential for enforcing regulations, yet current analytical methods like gas chromatography–mass spectrometry (GC-MS) and liquid chromatography–tandem mass spectrometry (LC-MS/MS) pose significant challenges. These techniques offer exceptional sensitivity but are expensive, labor-intensive, and require specialized laboratories. Sample preparation alone can involve multiple extraction and purification steps, making routine testing impractical for many growers, small food producers, and communities with limited resources.

This gap highlights the need for simpler, more portable detection tools like the **Pesticide Detection Strip Test** created by Attogene (catalog # AU2070). This rapid and low-cost strip-based test is transformative because it provides immediate visual results without laboratory instruments or equipment (**Figure 1**). By incorporating enzyme inhibition principles into a simple strip format, these tests allow pesticide detection in many nontraditional test environments. The test has a simple workflow that can be performed in less than 30 minutes.

Pesticide Detection Strip Test workflow:

Step	Time
1. Activation (phosphorothioate oxidation) step	5 min
2. Quench /Enzyme addition	5 min
3. Flow up strip	12 min
4. Detect	5 min

Water and Produce Testing:

Water - The test can be used to detect organophosphates and carbamates in water samples. Figure 2 shows how the test was used to detect 20 ppb organothiophosphate malathion pesticide in water.

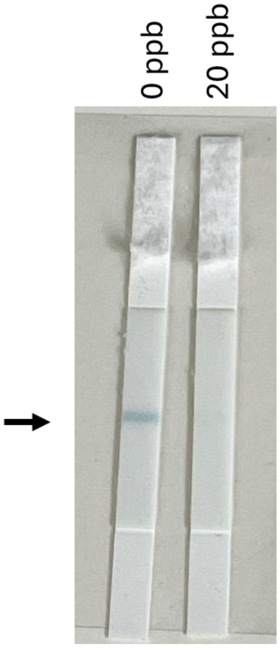

Figure 2: Detection of 20 ppb malathion in a water sample.

Produce - Next, we tested fruit and vegetable samples to determine its ability to detect Malathion. Organic winter squash, blueberries and tomatoes were sprayed with malathion according to the manufacturer's directions and allowed to dry before testing using the test (Figure 3). A strong test line is observed for tests of each of the untreated organic samples, while little or no test line is observed for the malathion treated produce samples.

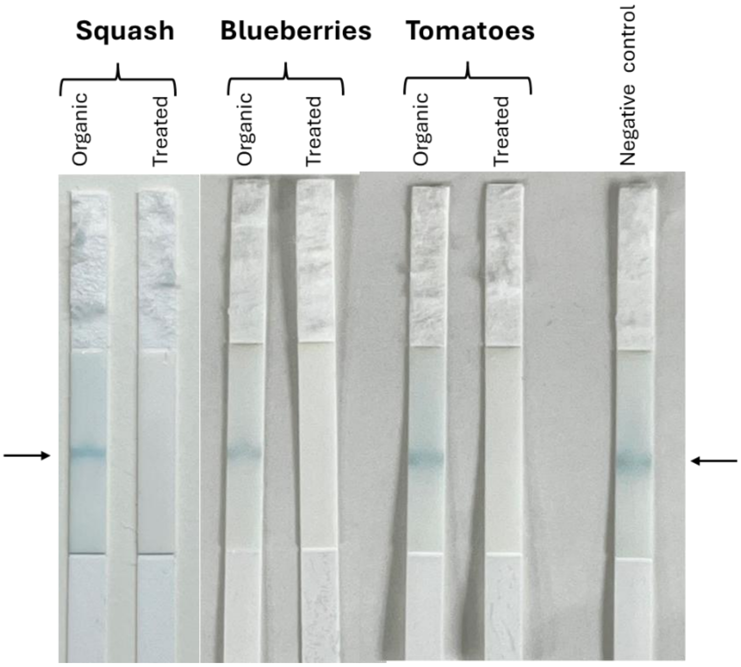

Figure 3: Rapid detection of malathion-treated fruits and vegetables using surface washings. The surface of organic (untreated) or malathion-treated produce was rinsed with 2 ml of water. The water was then tested using the Pesticide Detection Strip Test. The kit Negative Control was tested in parallel to provide a reference signal for the test line (as indicated by the arrow). The washings from malathion-treated produce show greatly diminished test lines.