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Pesticide Residues in Fruits and Vegetables from Farmers' Markets

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Abstract

Pesticides are important in crop production worldwide. Many commonly grown fruits and vegetables require pesticide protection. The consequences of using pesticides for food production can be far-reaching, and farm produce may contain pesticide residues that pose serious health and environmental risks. In this paper, we review the Electrical Penetration Graph (EPG) and explore the potential for its use in food safety. Several pesticide residues were found on produce obtained from farmers' markets. The results indicate that the EPG could be a useful tool for detecting pesticide residues. In conclusion, we emphasize the need for case-driven Integrated Pest Management (IPM) approaches that produce safe food and high yield.

Keywords: Food safety; Electrical penetration graph (EPG); Insecticide; Pesticide Residue; Integrated pest management (IPM)

Introduction

Food safety concerns continue to be important to agriculture in many parts of the world. Many farmers use chemical pesticides to control insect pests, weeds and diseases to obtain high yields, quality and blemish free appearance to meet standards imposed by consumers. Residues from pesticides may still be present on produce and may have long-term adverse effects on human health [1]. It is therefore not surprising that over 90 percent of consumers are concerned about pesticide and fertilizer residues in food and food products [2,3]. In the USA, farmers' markets represent an attractive outlet where consumers purchase fresh produce directly from the producer. The number of farmers' market has grown significantly, with a 79% increase from 1994 to 2002 [4]. A major reason for this trend is the fact that consumers believe produce from farmers' markets are fresher, pesticide-free and of higher quality [5,6] and there is little data available to support all of these claims. Pesticide detection methods are generally expensive, time consuming, and not suitable for field measurements. Simpler, yet innovative devices that are easy to use and capable of providing reliable information are needed.

The EPG was originally developed by McLean and Kinsey [7-9] with a number of recent enhancements [10,11] used to analyze, quantify, and compare feeding behaviors of hemipteran insects. It works when a test insect is attached to the monitor through a gold wire glued to its dorsum with conductive silver paint. Low-voltage current is introduced into the test plant via an electrode to the soil or plant's tissues. When the insect's stylets penetrate the electrified plant, the circuit is closed. Changes in voltage across the stylets are amplified and recorded as a time-varying waveform [12,13] and can be correlated with many types of feeding and non-feeding behaviors. The EPG has been used to investigate host plant resistance [14,15] transmission of plant viruses [16,17] action of insecticides [18-24] etc. In the area of food safety, EPG technology can be used to study the response of insect pests on fresh produce with the goal of determining the least amount of pesticide residue that will elicit feeding without killing the test insect. Waveforms obtained will be compared with those obtained with untreated produce and thus develop standard waveforms that would serve as the litmus test for detecting pesticide residue on produce.

In one study [25] the southern green stink bug *Nezara viridula* L was exposed to fresh fruits and vegetables from farmers' markets or roadside stands situated along the I-85 and I-40 transect at the following locations: Auburn, Tuskegee and Montgomery (AL), Gaffney (SC) and Greensboro (NC), and pesticide residue of these produce analyzed. A dose-response curve for the neonicotinoid Imidacloprid (Provado®, Bayer Crop Science, NC) was obtained by exposing stink bugs to a range of doses (0.08-0.75mg/ml). The feeding behavior of adult stink bugs on cowpea pods treated with 0.08 and 0.75mg/ml Imidacloprid and untreated pods (control) was evaluated using the EPG.

Discussion

From the dose response curve, the LD_{50} for Imidacloprid at 24, 48 and 72h was 0.1195mg/ml, 0.0580mg/ml and 0.0168mg/ml respectively. Mortality increased with increasing dose to 100% after 72h in all doses tested. From the bioassay experiment no mortality was observed on tomato, squash, green beans and okra from all locations after 24 and 48h. After 24h, mortality for Auburn cucumbers was (11%); Montgomery and Auburn peaches (22%); and 33% for Tuskegee peaches. After 48h, mortality on peaches from Tuskegee was (67%); Auburn and Montgomery (56%); Gaffney (22%); Greensboro (11%) and 33% for apples from Greensboro. Chlorpyrifos, Thiamethoxam, Endosulfan, Bifenthrin and Esfenvalerate residues were found on produce; however, peaches had Chlorpyrifos residue (0.074ppm) above the EPA tolerance level (0.05ppm). EPG waveform patterns indicated that, when at rest, (i.e. when the insect was not moving), a straight line was recorded at the base. Stink bugs did not feed immediately when placed on treated cowpea pods; they crawled and pulled the gold wire and made repeated attempts at penetrating pod wall with their stylet for a few minutes (Figure 1a). After stylet penetrated the pod wall, a stable voltage output with little variation in amplitude was observed (salivation). After this, either the stylet was withdrawn, or variable spiky waveform patterns (Figures 1b-1d) which varied over time were formed. The stink bug fed on untreated pea and exhibited feeding waveforms (Figures 1b-1d). However, when transferred to pod treated with 0.08mg/ml and 0.77mg/ml feeding waveform patterns were disrupted and insect became paralyzed. EPGs with feeding disruption and distorted patterns have been reported by other workers [18,20-24,26].

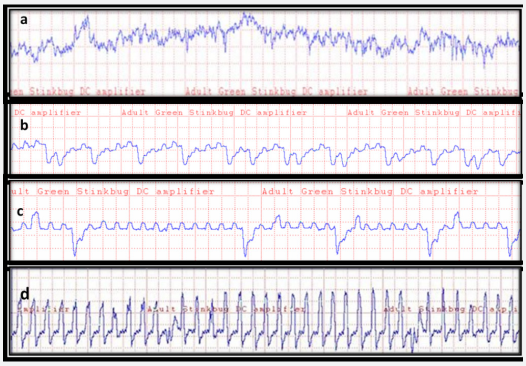

Figure 1: EPG representative waveform patterns generated by the southern green stink bug (a) non-feeding (b-d) feeding.

Conclusion

These results indicate that fruits and vegetables sold in farmers' markets used in our study contained insecticide residues at levels that would kill stink bugs. These levels cannot be considered safe for human consumption. EPG can thus be used as a reliable tool to detect presence of pesticide residue levels that are dangerous to humans in a fairly short amount of time. Further studies using minimal doses that would allow feeding but not paralyze or kill the insect are needed.

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