Contents Lists Available at: https://journal2.unusa.ac.id/
Medical Technology and Public Health Journal
Journal Home Page: https://journal2.unusa.ac.id/index.php/MTPHJ

Research Article

THE IMPACT OF PESTICIDE USE ON RESIDUALS IN VEGETABLE PRODUCTS IN PALANGKA RAYA

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DOI: *10.33086/mtphj.v9i1.5924*

Article History:
Received, June 01st, 2024
Revised, August 06th, 2024
Accepted, December 12th, 2024
Available Online: May 04nd, 2025

Please cite this article as:
Normila,et. al., "The Impact Of Pesticide Use On Residuals In Vegetable Products In Palangka Raya" Register: Medical Technology and Public Health Journal, Vol. 9, No. 1, pp. 31-38, 2025

ABSTRACT

Pesticide use in agriculture is essential for controlling pests and diseases; however, overuse often results in environmental contamination and health issues. This study explores the presence of pesticide residues in vegetables from Palangka Raya. The overuse of pesticides—whether in type, amount, frequency, or dosage—contaminates crops and poses risks to humans through inhalation and ingestion. Analytical observational research was conducted, using purposive sampling to collect vegetable samples. These samples were analyzed qualitatively with a pesticide detection kit, and the results were correlated with pesticide use on the farms. Data analysis was performed using McNemar's non-parametric test. The results revealed that 20% of the vegetable samples contained pesticide residues. These residues were significantly associated with a spraying frequency of more than twice per week (p = 0.016) and improper pesticide dosage (p = 0.039). This study underscores the impact of pesticide application practices on residue levels in vegetables, emphasizing the need for regulated use to minimize health risks.

Keywords: *Residue; Pesticide; Vegetables; Agriculture;*

INTRODUCTION

Pests and plant diseases pose significant challenges in the agricultural sector. Sudden outbreaks of these threats can lead to severe crop loss, negatively affecting the quality and quantity of agricultural output. Consequently, farmers often resort to chemical pesticides, seeing this as the only viable solution to their problems (Nuryanto, 2018).

However, the long-term excessive reliance on pesticides has detrimental effects on the environment and poses health risks to humans. Many farmers apply these chemicals recklessly and often disregard the recommended guidelines due to lacking knowledge and basic training. This careless use of pesticides can result in contamination, as residues may linger on the plants, directly or indirectly. Research has shown the presence of pesticide residues in various food products (Tatuhey et al., 2020).

The existence of pesticide residues in food items contradicts consumer safety and hygiene standards necessary for ensuring that products are safe for consumption. Food should be free from contaminants, toxins, pesticides, and harmful microbes to be considered safe and healthy for consumers (Khomsan & Wahyudi, 2015).

Pesticide residues, which can persist after multiple applications, may come into contact with humans through various means. These residues can be inhaled while breathing or ingested via food and drinking water (Ardiwinata & Nursyamsi, 2012; Kurnia, 2017). These chemical residues can also be absorbed through plant roots from the soil. When pesticides are present in food, they can accumulate in bodily tissues, especially those that contain fat. The buildup of these residues in humans can lead to serious health issues, including liver and kidney damage, nervous system dysfunction, weakened immunity, as well as congenital disabilities, allergies, and cancer (Amilia et al., 2016; Marbun et al., 2015).

In a study by (Alen et al., 2015) examined lettuce at the Padang Luar Market, utilizing mass gas chromatography to detect pesticide residues. The analysis revealed that the lettuce contained profenofos pesticide residues at levels of 5.92 ppm, significantly exceeding the Maximum Residue Limit (MRL) established by The Japan Food Chemical Research Foundation, which is set at 0.05 ppm. This excessive level is attributed to farmers' lack of knowledge regarding proper pesticide use, leading to violations of the recommended dosage, application timing, and chemical mixing guidelines.

Several studies have identified high levels of pesticide residues in various vegetables across different regions, indicating a widespread issue of pesticide misuse and contamination. For example, lettuce has been reported to contain pesticide residues that exceed safe limits, and similar issues have been observed in other vegetables, such as tomatoes, spinach, and cucumbers. This widespread contamination highlights a significant gap in understanding the relationship between specific pesticide usage practices—such as dosage and frequency of application—and the levels of pesticide residues found in agricultural products. In Indonesia, pesticide residues in fruits and vegetables are particularly concerning due to the extensive use of pesticides in agriculture. Although laboratories generally perform well in pesticide residue analysis, there is a need for improvement, especially in multi-residue analysis. As the number of target pesticides for analysis increases, laboratories must upgrade their capabilities. This gap in understanding the link between pesticide usage practices and residue levels underscores the urgency and importance of our current study (FAO, 2015; Pitoi et al., 2022)

Pesticide residues can negatively impact human health, causing both acute and chronic poisoning. Symptoms of mild acute poisoning may include headaches, mild skin irritation, body aches, dizziness, and diarrhea. In contrast, severe acute poisoning can present with more serious symptoms such as nausea, chills, stomach cramps, difficulty breathing, excessive drooling, dilated pupils, and an increased heart rate. Chronic poisoning is more challenging to identify, as it often does not produce distinct signs or symptoms and may not be felt immediately. However, the continuous accumulation of pesticides over time can lead to significant health issues. These may include eye and skin irritation, cancer, miscarriages, congenital disabilities, and various disorders affecting the neurological system, liver, kidneys, and respiratory system. These health concerns are frequently associated with the use of pesticides (Adams et al., 2019; Mrema et al., 2017; Sankhla, 2018).

This research aims to identify the types and levels of pesticide residues found in various vegetables sold at the Palangka Raya market. Additionally, the study aims to assess the correlation between these residue levels and farmers' pesticide application practices, including dosage and frequency of application. By addressing the knowledge gap regarding the impact of pesticide use practices on residue levels, this study seeks to provide valuable data that can inform improved pesticide management practices and policies to protect consumer health.

MATERIAL AND METHODS

This research utilizes an analytical observational approach to examine the use of pesticides in agriculture and the residues found in vegetable production. The study population includes all vegetable farms in the Palangka Raya region, with 20 farms selected as research samples through purposive sampling. The focus was on tomatoes, chili peppers, and yardlong beans due to their typical consumption and reported issues with pesticide residues. The research was conducted in the Palangka Raya region from June to August 2021.

Vegetable samples were carefully collected from selected agricultural sites and tested for pesticide residues. They were analyzed qualitatively using the G9 Fast Pesticides Detection Kit, which identifies and measures vegetable pesticide residues. In addition to the detection kit, structured interviews and questionnaires were utilized to gather farmers' information on pesticide use practices. The data collection was aimed to analyze pesticide use patterns, including the types of pesticides applied, the quantities used, and the frequency of application.

McNemar's test assessed the relationship between pesticide application practices and residue levels. The research underwent an ethical review to ensure compliance with ethical standards, and informed consent was obtained from the farmers participating in the survey regarding their pesticide use practices.

This comprehensive approach provides a detailed understanding of how pesticide usage in agricultural practices affects the presence of residues in vegetables, offering valuable insights for improving food safety and regulatory practices.

RESULTS AND DISCUSSION

Testing for organophosphate and carbamate pesticides was performed using the G9 rapid test pesticide detection kit. The results from analyzing 20 vegetable samples collected from twelve agricultural sites in Palangka Raya are summarized in Table 1. The G9 rapid test kit facilitated efficient and accurate detection of pesticide residues, providing a comprehensive view of contamination levels across different agricultural locations. This data is essential for evaluating the extent of pesticide residues in local produce and formulating strategies to mitigate potential health risks associated with pesticide exposure. The detailed results, including the specific levels of residues detected and their distribution across the sampled sites, offer valuable insights into current agricultural practices and their implications for food safety.

Table 1. Pesticide Residue Identification in Vegetables

Vegetables	Pesticide Residue		Total
	Negative	Positive	
Tomato	5	3	8
Chili Pepper	6	1	7
Yardlong Bean	5	0	5
Total	**16**	**4**	**20**

The data presented in Table 1 reveals the presence of pesticide residues in various vegetable samples. Of the 20 tested samples, tomatoes exhibited the highest contamination rate, with 3 positive results out of 8 samples, corresponding to 37.5%. In contrast, chili peppers had a lower contamination rate, with only 1 positive result out of 7 samples, about 14.3%. Notably, yardlong beans showed no pesticide residues, with all 5 samples testing negative. Tomatoes and chilies were the only vegetables that returned positive results. Farmers work diligently to prevent crop failures in the tomato and cayenne pepper industries, particularly during the rainy season when these plants are more vulnerable to pests (Harjadi, 2019).

Of the 20 samples tested, 4 (20%) were found to have pesticide residues. This result indicates that a significant portion of the vegetable samples from the agricultural sites in Palangka Raya are contaminated. These findings underscore the need for stringent monitoring and regulation of pesticide use to ensure the safety of agricultural produce. The variation in contamination rates among different types of vegetables may be due to differences in susceptibility to pests, the types of pesticides employed, and the application methods. Further investigation into these factors could yield valuable insights into practical strategies for reducing vegetable pesticide residues.

Table 2. Pesticide Dosage, Spraying Frequency, and Pesticide Residues

No.	Pesticide Usage	Pesticide Residue				Sig (p)
		Negative		Positive		
		n	%	n	%	
1.	Pesticide Dosage					0,039
	According to Dosage	8	40	1	5	
	Inappropriate Dosage	8	40	3	15	
	Total	16	80	4	20	
2.	Spraying Frequency					
	Once a week	9	45	0	0	0,016
	More than 2 times a Week	7	35	4	20	
	Total	16	80	4	20	

Fisher's Exact Test = 0,001 (<0,05)
Cramer's V = 0,961
OR = 0,037

The McNemar test results indicated a significant relationship (p=0.039) between the use of pesticides in amounts exceeding recommended levels and pesticide residues on the tested vegetables. This result suggests that improper pesticide application, a common practice among farmers, is a significant factor contributing to the accumulation of pesticide residues in vegetables. According to Suyud et al. (2019), many farmers do not follow the recommended dosages or application guidelines on pesticide labels. Instead, they often increase the dosage when faced with severe pest infestations or plant diseases, hoping to prevent crop failures. This approach results in elevated pesticide residues in agricultural products (Sapitri et al., 2019).

Several theories explain the causes of pesticide residues in vegetables. One significant factor is farmers' lack of knowledge and training regarding proper pesticide usage. Many farmers rely on traditional practices and advice from peers, which may not align with recommended guidelines. Additionally, inappropriate measurement tools like bottle tops can lead to inaccurate dosages.

Economic pressures and the need to meet market demands often compel farmers to apply higher pesticide doses to ensure crop survival and yield (Akter et al., 2018; Mariyono et al., 2018).

The amount of pesticide residues found in the sampled vegetables was influenced by how frequently pesticides were sprayed ($p < 0.016$). Chili plants are typically sprayed two to three times, depending on the weather conditions. Morning spraying lasts for two hours; if it rains, an additional round of spraying is conducted to prevent pests from returning. This practice is considered an effective method for reducing crop failure, especially for chili plants with high economic value. However, applying pesticides in amounts that exceed regulatory limits and disregard ecological balance can lead to serious negative consequences. These adverse effects include the resilience and resurgence of target pests, increased non-target secondary pests, and harmful impacts on non-target organisms. For instance, chili curly disease, caused by a virus with no available treatment, is one such consequence. Furthermore, pesticide overuse can lead to poisoning, affecting both farmers who apply the pesticides and consumers who eat produce containing pesticide residues (Sapitri et al., 2019).

These findings support Kurnia's research (2017), which discovered that farmers often do not apply pesticides according to Integrated Pest Management (IPM) principles. The IPM recommends using pesticides only as a last resort if other pest control methods prove ineffective. When pesticides are necessary, the aim is to use the minimum amount required to be effective, ensuring that the application does not exceed the levels that would cause economic harm or damage to the plants. In agricultural settings, failure to follow the five essential guidelines for pesticide application—timeliness, targeting the correct area, dosing appropriately, employing the proper method, and selecting the appropriate type—can lead to pesticide residues and biomagnification (Kurnia, 2017).

Farmers often misunderstand the proper and responsible use of pesticides, leading to inappropriate application methods. Although many farmers are aware of the correct techniques, they frequently underestimate the needed doses, believing that the provided instructions are ineffective (Hlihor et al., 2019). A significant factor contributing to this issue is the high cost of pesticides, which pressures farmers to minimize expenses by estimating the amount they need based on the actual pest attacks they observe. However, this practice can have detrimental effects. Applying excessively high doses increases selection pressure on pests and accelerates the development of resistance to the chemicals (Hlihor et al., 2019). Conversely, using doses that are too low can lead to pest tolerance to the insecticides. According to agricultural principles, if the dose is too high, the pests may die, but the collateral damage can be severe. Non-target organisms that are vital for maintaining the ecosystem may also perish due to pesticide exposure. This includes natural predators, which play essential roles in pest control, as well as the potential for water and soil contamination. In the worst-case scenario, farmers themselves could be poisoned, as the active ingredients can cling to the crops. There is a concern that if the dosage applied is below the recommended levels, the pests might not die but instead become temporarily intoxicated, ultimately recovering later. Therefore, it is crucial for farmers to read and adhere to pesticide use labels to mitigate the negative impacts associated with improper pesticide application (Xu et al., 2018).

The findings of this study align with existing literature, supporting the hypothesis that improper pesticide use leads to increased pesticide residues in vegetables. The significant relationship between pesticide dosage, spraying frequency, and residue levels highlights that following recommended pesticide guidelines is crucial for minimizing contamination..

Several solutions can be implemented to reduce pesticide residues in vegetables. First, it is essential to provide farmers with education and training on proper pesticide use, including accurate dosage measurement and application techniques. It can be achieved through extension services and farmer field schools. Second, promoting integrated pest management (IPM) practices can help reduce reliance on chemical pesticides. IPM involves using biological, cultural, and mechanical control methods to manage pests. Third, regular monitoring and enforcement of pesticide regulations should be implemented to ensure compliance and reduce misuse. Finally, developing and promoting safer, less persistent pesticides can help minimize residue levels while protecting crops.

CONCLUSION AND SUGGESTION

Pesticide residues were detected in 20% of the agricultural products tested. The study revealed a significant impact of pesticide dosage and spraying frequency on the levels of pesticide residues present in these products. The research focused on several key variables, including pesticide residue and the measurable amount of pesticide remaining on or in agricultural products after application. Pesticide dosage: the specific quantity of pesticide applied per unit area during each application. Spraying frequency: the number of times pesticides are applied to crops over a specified period..

It is essential to improve training for farmers on proper pesticide application techniques to mitigate the risks associated with pesticide residues, emphasizing accurate dosage and the frequency of spraying. Promoting eco-friendly farming practices, such as integrated pest management (IPM), can reduce dependence on chemical pesticides. IPM integrates biological, cultural, and mechanical control methods for more sustainable pest management. Regularly monitoring pesticide residues in agricultural products is crucial to ensure compliance with safety standards and identify areas needing improvement..

Additionally, consumer education campaigns should highlight the importance of adequately washing produce and encourage selecting organic products to minimize pesticide exposure. Strengthening regulatory measures regarding pesticide usage is vital for protecting public health and preserving environmental integrity. We can significantly reduce pesticide residues in agricultural products by addressing these areas and safeguarding consumer health and the environment.

ACKNOWLEDGEMENT

We want to express our sincere gratitude to the Health Polytechnic of the Ministry of Health in Palangka Raya for their financial support, which made this research possible. Additionally, we appreciate the farmers who generously participated as respondents in this study. Their cooperation and willingness to share valuable insights have significantly contributed to the success of our research efforts.

CONFLICT OF INTEREST

There are no conflict of interests on this research.

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