EFFECTIVENESS OF PESTICIDE STORAGE AND RINSE HOUSE IN REDUCING FARMERS' PESTICIDE CONTAMINATION

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Abstract. Pesticide safety management to reduce pesticide levels in the blood of farmers needs to be equipped with supporting facilities including pesticide storage and rinse house with complete PPE and personal hygiene facilities. This study aimed to analyze the effectiveness of pesticide storage and rinse house in reducing pesticide levels in the blood of farmers in order to protect the dangers of pesticides on farmers. The research method used a one-group pre-test and post-test design with systematic random sampling using as many as 17 farmers who are actively using inorganic pesticides. The study began with an initial examination of the cholinesterase enzyme as a pre-test value. The intervention in using pesticide storage and rinse house was carried out for two weeks starting from mixing, spraying, and personal hygiene. The post-test was carried out with the same examination as the pre-test. Data were analyzed using paired sample t-test method with 95% confidence intervals. The results showed that there was an increase in cholinesterase by 7.61% with a *p*-value of 0.017 (significant) with a very strong correlation of 0.910. Therefore, it can be concluded in this study that the correct use of pesticide storage and rinse house is effective in reducing pesticide levels in the blood. The intervention in the form of the use of pesticide storage and rinse house can significantly increase cholinesterase enzyme levels by 7.61% compared to before (p=0.017). Future studies are needed to control factors that may be related to the blood pesticide levels over a longer period of time.

Keywords: effectiveness, facility, pesticide safety management, farmers, pesticide contamination

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INTRODUCTION

Agricultural activities are closely related to the use of pesticides to increase crop yields through the control of insects, rodents, fungi, and mollusks (Ali *et al*, 2020; Hughes *et al*, 2021). Most farmers are more interested in using inorganic pesticides because they can kill targets quickly. However, in addition to having a positive impact on agricultural activities, the use of pesticides harms the health of farmers if they are not used safely, properly, and correctly. These negative impacts can cause acute symptoms such as indigestion, sweating, urinary tract disorders, bronchial disorders, bradycardia, twitching, watery eyes, and even coma. Also, chronic disorders in the form of headaches, nausea, vomiting, abdominal pain, blurred vision, and chest tightness. There is even some evidence that there is a relationship between pesticide exposure and reproductive disorders and cancer (Ali *et al*, 2020; Damalas and Eleftherohorinos, 2011; Hughes *et al*, 2021; Nganchamung *et al*, 2017; Sombatsawat *et al*, 2014). Therefore, there is a need for pesticide safety management efforts to control the dangers of pesticide exposure to the body (Rosanti *et al*, 2021; Santaweesuk *et al*, 2020). This starts from reading the direction regarding the storage, mixing, handling, and spraying properly and correctly when buying (Jallow *et al*, 2017; Yawson, 2022). For there are health risks due to the dangers of pesticides at all stages of pesticide use.

Farmers in Demangan Village of Ponorogo Regency, which consist of rice and horticultural farmers such as corn, soybeans, green beans, chilies, shallots, and melons, use inorganic pesticides to control pests. Based on observations, rice farmers spray pesticides 2-3 times in one harvest period, while horticulture farmers spray pesticides 3-5 times in one week. The high intensity of spraying greatly affects the levels of pesticides in the body which can inhibit the activity of the cholinesterase enzyme in the body (Hotang *et al*, 2020; Nambunmee *et al*, 2021; Ramdan *et al*, 2020). A biomarker to determine the level of pesticide exposure in the body is biological monitoring of the activity of the cholinesterase enzyme (Ramírez-Santana *et al*, 2018; Sombatsawat *et al*, 2014). Based on the cholinesterase levels in farmers at Demangan Village, 10.53% were at very high risk, 29.82% at high risk, 45.61% at medium risk, and 14.04% at low risk (Rosanti *et al*, 2021). In addition, farmers also do not use standard Personal Protective Equipment (PPE) and have poor personal hygiene, so it is necessary to apply pesticide safety management.

Efforts to provide knowledge have been carried out, but to support safe farmer behavior, it is necessary to have adequate support facilities. Based on previous research, farmers who understand the dangers of pesticides have not been able to carry out pesticide safety management because they still prioritize their economy (Jallow *et al*, 2017). According to Röösli *et al* (2022), an effective strategy in controlling the use of pesticides is to modify processes, actions, and stages of activities including educational programs, stricter regulations, environmental improvements, and health promotion.

The researcher initiated the establishment of pesticide storage and rinse house as a facility to support pesticide safety management in collaboration with the village government, the community health center, and the health office. According to Röösli *et al* (2022) interventions involving multiple sectors are highly effective and sustainable. Interventions can affect an individual's knowledge, attitudes, beliefs, and skills and can also increase social support.

The house is equipped with Personal Protective Equipment such as coveralls, boots, gloves, aprons, face shields, and masks. According to Sabran and Abas (2021), Personal Protective Equipment (PPE) is very effective in protecting farmers' bodies from the dangers of exposure to pesticides. The house is also equipped with a first aid kit, fire extinguisher, and bathroom. In addition to storing Personal Protective Equipment (PPE) and needed equipment, the house is also used to store pesticides so they are not stored at home. Through the use of pesticide storage and rinse house, it is hoped that it will reduce pesticide exposure to farmers' bodies. Interventions in previous studies through multifaceted programs have been conducted, but have not evaluated the expected outcomes (Afshari *et al*, 2021). This study aimed to analyze the effectiveness of the use of pesticide storage and rinse house in reducing pesticide contamination in the blood of farmers in Demangan Village.

MATERIALS AND METHODS

The research method used in this study was a one-group pre-test/post-test design with systematic random sampling using as many as 17 farmers in Demangan Village who are actively using inorganic pesticides. The intervention was in the form of the use of pesticide storage and rinse house by farmers, starting from mixing, spraying, and personal hygiene within 2 weeks with strict control.

The study began with a pre-test, namely the examination of cholinesterase enzyme levels in the farmer's body before the intervention was carried out. After that, the intervention was carried out and then ended with a post-test, namely the examination of cholinesterase enzyme levels in the farmer's body after the intervention.

Cholinesterase enzyme levels in the body are an indicator of pesticide content in the blood of farmers. The method of analyzing cholinesterase enzyme levels in the blood used in this study was using a Cobas 8000 Modular Analyzer (Hitachi High-Technologies Corporation for Roche Diagnostic GmbH, Mannheim, Germany). The results of the cholinesterase examination were divided into 4 levels, namely 5-6.99 U/l (very high risk), 7-8.99 U/l (high risk), 9-10.99 U/l (medium risk), and 11-12 U/l (low risk) (Rosanti *et al*, 2021). Data were analyzed using Statistical Package for the Social Sciences (SPSS), Version 24 (IBM, Armonk, NY) with 95% confidence intervals to determine differences in cholinesterase enzyme levels in the blood of farmers before and after the intervention. Informed consent was obtained from each participant before the intervention was carried out.

This research was approved by the ethics commission of RSUD Dr. Hardjono Ponorogo with a registered number: 3502021K121442020082100002/IX/KEPK/2020.

RESULTS

Respondent sociodemographic profile

Based on Table 1, the results show that the 1 respondent (5.88%) aged ≤30 years old; 6 respondents (35.3%) aged between 31-40 years old; 4 respondents (23.53%) aged between 41-50 years old; 5 respondents (29.41%) aged between 51-60 years old; and 1 respondent (5.88%) aged between 61-70 years old. For the education attained, 3 respondents (17.65%) completed elementary school degree; 7 respondents (41.18%) completed junior high school degree; 6 respondents (35.29%) completed senior high school degree; and 1 respondent (5.88 %) with bachelor's degree. As for the length of working in the farm, 8 respondents (47.05%) worked for 10 years; 3 respondents (17.65%) worked for 11-20 years; 3 respondents (17.65%) worked for 21-30 years; and 3 respondents worked for 31-40 years. For frequency of spraying the pesticides, 8 respondents (47.06%)

Table 1
Sociodemographic characteristics of respondents (N = 17)

Characteristics	Frequency *n* (%)
Age (years old)	
30	1 (5.88)
31-40	6 (35.30)
41-50	4 (23.53)
51-60	5 (29.41)
61-70	1 (5.88)
Education	
Elementary school	3 (17.65)
Junior high school	7 (41.18)
Senior high school	6 (35.29)
Bachelor degree	1 (5.88)
Working period (years)	
10	8 (47.05)
11-20	3 (17.65)
21-30	3 (17.65)
31-40	3 (17.65)
Spraying frequency (times/week)	
1	8 (47.06)
2	5 (29.41)
3	4 (23.53)
Spraying duration (hours)	
1	2 (11.76)
2	6 (35.30)
3	8 (47.06)
4	1 (5.88)

Table 1 (cont)

Characteristics	Frequency *n* (%)
Land area (Hectare)	
<0.5-0.99	13 (76.47)
1-1.99	1 (5.88)
2-3	3 (17.65)
Types of sprayer	
Manual	5 (29.41)
Electric	12 (70.59)
Smoking habit	
Yes	14 (82.35)
No	3 (17.65)
Body mass index	
Underweight (<18.5 kg/m^2)	1 (5.88)
Normal (18.5-23.0 kg/m^2)	8 (47.06)
Overweight (>23.0 - 27.5 kg/m^2)	8 (47.06)
Obese (>27.5 kg/m^2)	0 (0.00)

kg/m^2: kilogram per square meter

sprayed once per week; 5 respondents (29.41%) twice per week; and 4 respondents (23.53%) three times per week.

The duration of spraying done by respondents varies; 2 farmers (11.76%) sprayed for 1 hour/day; 6 farmers (35.30%) for 2 hours/day; 8 farmers (47.06%) for 3 hours/day; and 1 farmer (5.88%) for 4 hours/day. For land area owned by respondents, 13 farmers (76.47%), owned a land area of <0.5-0.99 hectares; 1 farmer (5.88%) 1-1.99 hectares; and 3 farmers (17.65%) 2-3 hectares. There are two types of sprayers used by respondents, 5 farmers (29.41%) used manual sprayer while 12 farmers (70.59%) used electric sprayer. Fourteen farmers (82.35%) smoked while 3 farmers (17.65%) did not smoke. One farmer (5.88%) was underweight (body mass index (BMI) <18.5 kg/m^2); 8 farmers (47.06%) had BMI (18.5-23.0 kg/m^2); and 8 farmers (47.06%) were overweight (BMI <23.0 - 27.5 kg/m^2).

Cholinesterase enzyme level

Based on Fig 1, the results of the pre-test and post-test showed that there was an increase in the activity of the cholinesterase enzyme in the blood of 13 farmers. Farmers who experienced decreased level of the cholinesterase enzyme in the blood were Farmers B, C, F, and I.

Based on Table 2, the results show that the average cholinesterase enzyme levels in the blood of farmers before the intervention (pre-test) was 9.25 U/l, then increased after the intervention (post-test) to 9.95 U/l. Descriptively, cholinesterase enzyme levels in the blood increased by 0.704 or 7.61% from the previous examination. The difference in cholinesterase enzyme levels between pre-test and post-test is significant (p=0.017). Based on the correlation coefficient score of 0.910, it is known that the pesticide storage and rinse house intervention is effective to increase blood cholinesterase enzyme, which means that the correlation is very strong.

DISCUSSION

The average cholinesterase enzyme levels before and after the intervention were significantly different (p=0.017). Farmers' blood pesticide levels decreased after the being an intervention was implemented. The risk of pesticides exposure begins with purchasing, storing, mixing, handling, spraying, and personal hygiene, claimed Damalas and Eleftherohorinos (2011).

The blood levels of the cholinesterase enzyme increased in Farmers B, C, F, and I, before (pre-test) and after the intervention (post-test) though not significantly. Farmer B's cholinesterase enzyme before the intervention (pre-test) was 8.358 U/l and the post-test level was 8.29 U/l. Increases of cholinesterase enzyme were also observed in Farmer C whose pre-test level was 9.676 U/l and post-test was 9.297 U/l; Farmer F's pre-test was 10.513 U/l and post-test was 10.373 U/l; and Farmer I's pre-test was 8.561 U/l and post-test was 8.021 U/l. According to the data collected, Farmers B, C, F, and I spray three times each week for two to three hours each time and they have a land area of more than 0.5 hectares. Because large areas need more pesticides, so the farmers increased the frequency and duration of spraying. Pesticide in the blood is influenced by frequency and duration of spraying (Dwiyanti *et al*, 2018). Damalas and Eleftherohorinos

Table 2
Farmers' blood cholinesterase levels before and after the intervention

Farmers	Cholinesterase level	
	Before intervention (Pre-test), U/l	After intervention (Post-test), U/l
A	9.510	10.936
B	8.358	8.290
C	9.676	9.297
D	5.465	5.569
E	9.415	10.116
F	10.513	10.373
G	6.816	8.012
H	12.362	13.185
I	8.561	8.021
J	10.784	11.044
K	9.690	9.737
L	12.512	16.145
M	6.857	9.138
N	12.000	12.121
O	9.080	9.418
P	5.785	7.057
Q	9.901	10.917

U/l: unit per liter

Table 3
Statistical test results of the effectiveness of pesticide storage and rinse house in reducing pesticide contamination in the blood of farmers

Examination	Mean	Mean difference	Sig (2-tailed)	Correlation
Pre-test	9.25	0.704	0.017	0.910
Post-test	9.95			

Sig: Significance when $p < 0.05$

(2011) recommended frequency of pesticide spraying is three times a week while duration of pesticide spraying is under five hours for each activity.

According to a study by Giannandrea and Iezzi (2014), interventions in agriculture to lower pesticide levels in farmers' blood had been carried out using a variety of techniques, including counseling, training, or the promotion of safe behavior through pre-test and post-test measures. All of these methods have been found to be effective. However, initiatives to promote and educate the farmers about health must be carefully monitored. The usage of a pesticide storage and rinse house was provided to farmers under strict monitoring. Statistical testing revealed that this intervention might greatly improve the activity of the cholinesterase enzyme in the blood where the level of pesticide was decreased by 7.61% as compared to before. According to Nishant and Upadhyay (2016), the educational intervention has a positive impact on good and correct pesticide handling practices. Evaluation of an intervention is very necessary to determine the effectiveness of the program carried out (Afshari *et al*, 2021).

The trial in this study involved a series of interventions that lasted for two weeks started with instruction regarding the mixing, spraying, and personal hygiene activities as well as the usage of pesticide storage, rinsing, and personal protection equipment. For two weeks, researchers recorded the farmers' spraying regimen. The research team overssaw the activities at the time the farmers did their spraying. Farmers were instructed to wash their sprayers and Personal Protective Equipment after finishing.

Starting with the mixing activity in the rice field area, the intervention in this study was carried out by wearing full Personal Protective Equipment (PPE), including coverall, gloves, boots or rubber shoes, an apron, a face shield, and a mask of respirator. If worn properly, personal protection equipment can be helpful in reducing exposure to the risks that pesticides provide to the body, such as spills and splashes (Bradman *et al*, 2009; Kurnia Sari *et al*, 2018). Education related to Personal Protective Equipment on the use of pesticides provides positive changes to farmer behavior (Nishant and Upadhyay, 2016). To avoid contaminating family members particularly youngsters who are extremely vulnerable, the mixing activity was also carried out at the pesticide storage and rinse house (Mequanint *et al*, 2019). Farmers have to use/wear full Personal Protective Equipment during the spraying activity, as well as for the mixing activity. Researchers kept farmer spraying within the permitted value range in terms of frequency and duration.

Farmers were expected to practice personal hygiene following the spraying standard operation, including cleaning the spraying equipment while wearing full Personal Protective Equipment and then taking a shower. The pesticide storage and rinse house were equipped with all the essential capabilities. If farmers do not immediately take a shower after spraying, it can enhance the absorption of pesticides in the body through the skin and be considered a carry-home pesticide exposure pathway, which has a significant impact on pesticide contamination in the blood (Santaweesuk *et al*, 2020; Thao *et al*, 2019).

Since pesticide use is currently widespread used, new approaches and creative thinking are required to protect human health, agricultural productivity, and the environment (Nicilopoulou-Stamati *et al*, 2016). Thus, it is envisaged that the usage of pesticide storage and rinse houses will lessen the dangers of pesticide exposure to the bodies of farmers. Continuous supervision and educating are required to ensure the sustainability of this intervention program (Maddah *et al*, 2020). Future research is required to manage variables that can affect blood levels of pesticides over a longer time span.

In summary, intervention in the form of the use of pesticide storage and rinse house starting from mixing, spraying, and personal hygiene with strict control can significantly increase cholinesterase enzyme levels in the blood of farmers by 7.61% compared to before. Continuous monitoring and education efforts related to pesticide safety management are needed to maintain the sustainability of safety behavior in the use of pesticides. In the future, there is a need for studies on the ability to strictly control all variables that can affect the activity of pesticide levels in the blood of farmers, such as frequency, duration, land area, and so on.

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CONFLICT OF INTEREST DISCLOSURE

We declare no conflict of interest.

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