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Determinant Factors Disrupting Cholinesterase Enzyme Activity in the Blood of Shallot Spraying Farmers

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ABSTRACT
The use of pesticides can result in environmental pollution and poisoning. Shallot farmers have been poisoned by organophosphate pesticides. Organophosphates can affect the nervous system by inhibiting the activity of the enzyme cholinesterase. This study aimed to analyze the determinant factors that influence the cholinesterase enzyme in the blood of shallot farmers. One of the important benefits of this research was the prevention and control of organophosphate pesticide poisoning. This type of research was observational. The population was 38 shallot spraying farmers, sample were 33 people chosen randomly. The research variables were the cholinesterase enzyme in the blood, type of pesticide, age, length of service, frequency of spraying, education, knowledge and drinking water intake. Data were analyzed using Chi-Square. 30,3% of shallot farmers had abnormal cholinesterase enzyme. The cholinesterase enzyme in the blood was related to the type of insecticide (p= 0.000), length of service (p= 0.035), spraying frequency (p= 0.004), education (p= 0.000) and water intake (p= 0.031). It is important to increase farmers' understanding of the dangers of pesticides and how to use pesticides safely.

Keywords: Cholinesterase Enzyme, Pesticides, Shallot Farmers

INTRODUCTION

Indonesia is a tropical country that has fertile land and is suitable for production in agriculture. The agricultural sector is a sector that has a strategic position in the structure of national economic development, it can be seen from the number of people who work as of August 2023 as many as 139.85 million people there are 39.5 million people who work in the agricultural sector and that number is equivalent to 28.21% of the total working population as of August 2023[1].

The sector of agriculture that has a broad scope is the horticulture subsector. Horticulture includes vegetables, fruits, ornamental plants, and medicinal plants. Based on data from the Central Statistics Agency (BPS) in 2013 the results of the complete enumeration of the 2013 Agricultural Census the number of agricultural business households in the horticultural subsector in Indonesia amounted to 10,602,147 households.

The leading horticultural subsector is shallot farming. Nganjuk in 2022 ranked first as the largest producer of shallots in East Java with a total harvest production of 1,939,881 quintals with a land area of 17,345 hectares. The level of production of good horticultural crop cultivation determines the success of the horticultural farmers business in Indonesia. So it must be prevented and suppressed as low as possible everything that can reduce agricultural productivity.

Farmers use pesticides to protect agricultural products from Plant Disturbing Organisms (OPT) to prevent and reduce the possibility of a decrease in agricultural productivity. The negative impact of continuous use of pesticides can result in

pesticide poisoning and pesticide pollution in the environment. The longer the working period of a farmer, the lower the farmer's blood *cholinesterase* levels[2].

Budiawan, in 2014 conducted a study on risk factors associated with low *cholinesterase* levels in shallot farmers in Nguresti Pati. This study used a cross-sectional research design, data collection through interviews and laboratory examinations. Findings showed a significant correlation between *cholinesterase* enzyme activity in farmers and various risk factors, including frequency of pesticide spraying, use of personal protective equipment (PPE), health status, attitudes, and knowledge[3]. In line with the results of Budiawan's research, pesticide exposure to the human body with frequent frequency and with short intervals causes pesticide residues in the human body to be higher[4].

In 2020 Hardi, Muhammad Ikhtiar, and Alfina Baharuddin conducted research in Jenetallasa Rubia to determine the Correlation between pesticide use and blood *cholinesterase* levels among vegetable farmers. This study used a cross-sectional design, data collection through interviews and laboratory tests. The findings showed a significant correlation between the frequency and duration of pesticide spraying, as well as the length of work, with blood *cholinesterase* levels of vegetable farmers in Jenetallsa Village [5]. The longer the sprayer is in contact with pesticides, the higher the risk of pesticide poisoning due to prolonged exposure if the spraying steps are not carried out with proper procedures [6].

Research conducted by Christien Gloria Tutu, Aaltje Ellen Manampiring, and Adrian Umboh in 2020 in Lurukan Village examined factors related to *cholinesterase* enzyme activity in the blood of pesticide spraying farmers. This study used a cross-sectional design with data collection methods through interviews and laboratory tests. The results showed a significant correlation between work period, spraying duration, spraying frequency, and the use of Personal Protective Equipment (PPE) with *cholinesterase* enzyme activity. The use of PPE is the causal factor most associated with *cholinesterase* enzyme activity in pesticide spraying farmers in Rurukan Village [7]. In line with research that has been done, the use of incomplete PPE can cause pesticides to enter the body more easily, for example, such as absorbing through the skin and even inhaled through the respiratory tract because parts are not protected by PPE [8].

Previous research on factors affecting *cholinesterase* enzyme activity in farmer sprayers has several limitations. The generalizability of the research findings is limited because most of the studies were conducted in one particular region or population, so the results may not apply to a wider population. Therefore, studies with larger and more diverse samples are needed to ensure that the findings can be generalized to other populations. Previous studies did not consider what types of pesticides each farmer used while the types of pesticides used by farmers will also cause different effects as a result of their exposure. Previous studies tend not to consider more comprehensive variables. Therefore, further studies need to include variables such as age, tenure, frequency of spraying, education, knowledge, and drinking water intake of farmers to get a more holistic picture of the determinant factors that interfere with the work of the *cholinesterase* enzyme in shallot spraying farmers.

The farmer group Gemi Makmur is an shallot farmer group located in Bungur Village, Sukomoro District, Nganjuk Regency. This village is an shallot farming area. The farmers use pesticides to protect agricultural products from Plant Disturbing Organisms (OPT). Farmers spray pesticides with a high frequency of at least 3 times a week and even some farmers spray pesticides every day. There are 4 out

of 5 farmers who do not use personal protective equipment (PPE) such as not wearing complete clothing (bare chest) when working in the fields. This can lead to pesticide poisoning. In Bungur Village, Sukomoro Subdistrict, Nganjuk Regency, there has never been an examination of the *cholinesterase* enzyme and counseling about the dangers of pesticide use. Practical reality in the field shows that the occurrence of pesticide poisoning is often caused by a lack of public understanding of the dangers of pesticides and how to use pesticides correctly.

RESEARCH METHOD

This type of research is observational with a cross-sectional design. This research was conducted from January to June 2024 in Bungur Village, Sukomoro District, Nganjuk Regency. The population of this study were 38 shallot spraying farmers who are members of the Gemi Makmur farmer group in Bungur Village, Sukomoro District, Nganjuk Regency. The number of samples taken was 33 spraying farmers using simple random sampling technique which was done by lottery. The independent variables in this study are the type of pesticide, age, tenure, frequency of spraying, education, knowledge and drinking water intake, while the dependent variable is the *cholinesterase* enzyme in the blood. Data were collected using observation, interview, and laboratory examination of blood *cholinesterase* enzyme levels. The data that has been obtained was analyzed statistically with the *Chi-Square* test (a = 0.05) to determine whether there is a significant correlation between the independent variable and the dependent variable.

RESULT AND DISCUSSION

From the research that has been done, the results show that 30.3% of shallot farmers had abnormal cholinesterase enzymes, most of the farmers who spray shallots use Carbamate pesticides, aged less than equal to 52 years, have a working period of less than equal to 31 years, spray more than 2 times/week, educated ≥ junior high school, and have poor knowledge in the use of pesticides.

Table 1. Correlation between Pesticide Type and *Cholinesterase* Enzyme Level in the Blood of Shallot Spraying Farmers in 2024

Pesticide Type	*Cholinesterase* Enzyme Level				*pvalue*	orrelation Value	*ld Ratio*
	Normal		Abnormal				
	n	%	n	%			
Organophosphates	4	17,4	9	90,0			
Carbamate	19	82,6	1	10,0	0,000	0,564	42,750
	23	100,0	10	100,0			

Source: Primary Data, 2024

Table 1 can be seen that shallot spraying farmers who had normal *cholinesterase* enzyme levels 82.6% (19 farmers) used carbamate pesticides and shallot spraying farmers who had abnormal *cholinesterase* enzyme levels 90.0% (9 farmers) used organophosphate pesticides. The results of the statistical correlation test using the *Chi-Square* test obtained a *pvalue* of 0.000 the value is smaller α = 0.05 (0.000<0.05) then H0 is rejected, so it can be concluded that there is a significant correlation between the type of pesticide with *cholinesterase* enzyme levels in the blood of shallot spraying farmers.

The use of organophosphate pesticides is more potentially dangerous than carbamate pesticides because the inhibition caused by organophosphates is irreversible, which means that once the organophosphate binds to the enzyme *cholinesterase* the enzyme can no longer

function. This can cause prolonged toxic effects. Pesticides from the carbamate group are relatively easy to break down in the environment (not persistent) [9].

Table 2. Correlation between Age and *Cholinesterase* Enzyme Levels in the Blood of Shallot Spraying Farmers in 2024

Age	*Cholinesterase* Enzyme Level				*pvalue*	Correlation Value	*Odd Ratio*
	Normal		Abnormal				
	n	%	n	%			
> 52 years	8	34,8	7	70,0			
≤ 52 years	15	65,2	3	30,0	0,062	0,309	4,375
Total	23	100,0	10	100,0			

Source: Primary Data, 2024

Table 2 shows that shallot spraying farmers who had normal cholinesterase enzyme levels 65.2% (15 farmers) were less than 52 years old and shallot spraying farmers who had abnormal cholinesterase enzyme levels 70.0% (7 farmers) were more than 52 years old. The results of the statistical correlation test using the Chi-Square test obtained a pvalue of 0. 062 the value is greater α = 0.05 (0.062>0.05) then H0 is accepted, so it can be concluded that there is no significant correlation between age and cholinesterase enzyme levels in the blood of shallot spraying farmers.

The absence of a Correlation between age and cholinesterase enzyme levels in this study can be possible because the results of the identification of the types of pesticides used by farmers, almost most of the shallot spraying farmers who sampled used carbamate pesticides 60.6% (20 farmers). The results of this study are in line with the research of Saragih (2019) that there is no Correlation between age and Cholinesterase enzyme levels with a pvalue of 0,143.

Table 3. Correlation between Length of Service and *Cholinesterase* Enzyme Levels in the Blood of Shallot Spraying Farmers in 2024

Length of Service	*Cholinesterase* Enzyme Level				*pvalue*	Correlation Value	*Odd Ratio*
	Normal		Abnormal				
	n	%	n	%			
> 31 years	7	30,5	7	70,0			
≤ 31 years	16	69,6	3	30,0	0,035	0,345	5,333
Total	23	100,0	10	100,0			

Source: Primary Data, 2024

Table 3 shows that shallot spraying farmers who had normal cholinesterase enzyme levels 69.6% (16 farmers) had a working period of less than equal to 31 years and shallot spraying farmers who had abnormal cholinesterase enzyme levels 70.0% (7 farmers) had a working period of more than 31 years. The results of the statistical correlation test using the Chi-Square test obtained a pvalue of 0.035, this value is smaller □ = 0.05 (0.035 <0.05), so H0 is rejected, so it can be concluded that there is a significant correlation between length of service and cholinesterase enzyme levels in the blood of shallot spraying farmers.

The longer a sprayer is exposed to pesticides, the higher the risk of pesticide poisoning due to prolonged exposure. A long working period can cause a buildup of pesticides in the body, which then has the potential to cause symptoms of pesticide poisoning The longer the working period of a farmer, the lower the farmer's blood

cholinesterase level [2]. To reduce this risk, it is important to conduct early screening to prevent poisoning.

Table 4. Correlation between Spraying Frequency and *Cholinesterase* Enzyme Levels in the Blood of Shallot Spraying Farmers in 2024

Spraying Frequency	*Cholinesterase* Enzyme Level				*pvalue*	Correlation Value	*Odd Ratio*
	Normal		Abnormal				
	n	%	n	%			
> 2 times/week	8	34,8	9	90,0			
1 – 2 times/week	15	65,2	1	10,0	0,004	0,453	16,875
Total	23	100,0	10	100,0			

Source: Primary Data, 2024

Table 4 shows that shallot spraying farmers who had normal *cholinesterase* enzyme levels 65.2% (15 farmers) sprayed 1 - 2 times / week and shallot spraying farmers who had abnormal *cholinesterase* enzyme levels 90.0% (9 farmers) sprayed more than 2 times per week. The results of statistical correlation tests using the *Chi-Square* test obtained a *pvalue* of 0.004 the value is smaller $\alpha = 0.05$ (0.004 <0.05) then H0 is rejected, so it can be concluded that there is a significant correlation between the frequency of spraying with *cholinesterase* enzyme levels in the blood of shallot spraying farmers.

The more frequently farmers use pesticides, the greater the risk of pesticide poisoning. Frequent exposure to pesticides with a short time interval cau an increase in pesticide residues in the body. The results of this study are in line with the research of Hardi, Ikhtiar, and Baharuddin, 2020 that there is a correlation between spraying frequency and *cholinesterase* enzyme levels with a *pvalue* of 0,039 [5].

Table 5. Correlation between Education and *Cholinesterase* Enzyme Levels in the Blood of Shallot Spraying Farmers in 2024

Education	*Cholinesterase* Enzyme Level				*pvalue*	Correlation Value	*Odd Ratio*
	Normal		Abnormal				
	n	%	n	%			
elementary school	2	8,7	7	70,0			
junior high school	21	91,3	3	30,0	0,000	0,535	24,500
Total	23	100,0	10	100,0			

Source: Primary Data, 2024

Table 5 shows that shallot spraying farmers who had normal *cholinesterase* enzyme levels 91.3% (21 farmers) had a junior high school education or more and shallot spraying farmers who had abnormal *cholinesterase* enzyme levels 70.0% (7 farmers) had a elementary school education. The results of the statistical correlation test using the *Chi-Square* test obtained a *pvalue* of 0.000, this value is smaller $\alpha = 0.05$ (0.000<0.05), so H0 is rejected, so it can be concluded that there is a significant correlation between education and *cholinesterase* enzyme levels in the blood of shallot spraying farmers.

Formal education can increase a person's knowledge, so it is expected that those with higher education will understand the potential dangers of pesticide use and preventive methods. However, low level of knowledge is still a problem among farmers. The higher a person's level of education, the smaller the chance of poisoning in him because his knowledge

about poisons including how to use and handle poisons safely and on target will be higher so that the incidence of poisoning will be avoided [10].

Table 6. Correlation between Knowledge and *Cholinesterase* Enzyme Levels in the Blood of Shallot Spraying Farmers in 2024

Knowledge	*Cholinesterase* Enzyme Level				*pvalue*	Correlation Value	*Odd Ratio*
	Normal		Abnormal				
	n	%	n	%			
< 7	10	43,5	8	80,0			
≥ 7	13	56,5	2	20,0	0,053	0,319	5,200
Total	23	100,0	10	100,0			

Source: Primary Data, 2024

Table 6 shows that shallot spraying farmers who had normal *cholinesterase* enzyme levels 56.5% (13 farmers) scored more than equal to 7 and shallot spraying farmers who had abnormal *cholinesterase* enzyme levels 80.0% (8 farmers) scored less than 7. The results of the statistical correlation test using the *Chi-Square* test obtained a *pvalue* of 0.053 the value is greater α = 0.05 (0.053 0.05) then H0 is accepted, so it can be concluded that there is no significant correlation between knowledge and *cholinesterase* enzyme levels in the blood of shallot spraying farmers.

Someone who has good knowledge will not necessarily demonstrate good and safe behavior and attitudes. Farmers tend to regard signs of poisoning as normal and do not take appropriate action. Therefore, in this study no Correlation was found between the level of knowledge and c*holinesterase* levels. The results of this study are in line with Rahmawati dan Martiana, 2014 that there was no correlation between knowledge and *cholinesterase* enzyme levels with a *pvalue* of 0.560 [10].

Table 7. Correlation between Drinking Water Intake and *Cholinesterase* Enzyme Levels in the Blood of Shallot Spraying Farmers in 2024

DrinkingWater Intake	*Cholinesterase* Enzyme Level				*pvalue*	Correlation Value	*Odd Ratio*
	Normal		Abnormal				
	n	%	n	%			
< 2 liters	9	39,1	8	80,0			
≥ 2 liters	14	60,9	2	20,0	0,031	0,352	6,222
Total	23	00,0	10	100,0			

Source: Primary Data, 2024

Table 7 shows that shallot spraying farmers who had normal *cholinesterase* enzyme levels 60.9% (14 farmers) drinking water intake per day is more than equal to 2 liters and shallot spraying farmers who had abnormal *cholinesterase* enzyme levels 80.0% (8 farmers) drinking water intake per day is less than 2 liters. The results of the statistical correlation test using the *Chi-Square* test obtained a *pvalue* of 0.031 the value is smaller α = 0.05 (0.031 <0.05) then H0 is rejected, so it can be concluded that there is a significant correlation between drinking water intake and *cholinesterase* enzyme levels in the blood of shallot spraying farmers.

The availability of sufficient water in the body allows the skin to excrete toxins through sweat, helping the metabolic system to eliminate toxins efficiently. However, if the body is dehydrated, this process will be disrupted so that toxins can accumulate. The results of this study are in line with research conducted in 2020 on the

effect of drinking water intake and storage time on *cholinesterase* enzyme activity in blood samples showing the results that drinking water intake affects the inhibition of AchE enzyme activity [11]. Acute and chronic *cholinesterase* inhibition can have an effect on weight loss as well as a decrease in food and water intake [12].

This study was conducted on shallot spraying farmers in Bungur Village, Sukomoro District, Nganjuk Regency, so the results cannot be generalized to the population of farmers in other areas. The method used was cross-sectional observational, which provides a picture at one point in time and cannot show changes or long-term effects of pesticide exposure. Analysis of the Correlation between pesticide type, age, length of service, spraying frequency, education, knowledge, and drinking water intake with *cholinesterase* enzyme levels showed that the variables significantly associated were pesticide type, knowledge, spraying frequency, length of service, and drinking water intake of farmers. However, this study did not consider other relevant variables such as the use of Personal Protective Equipment (PPE) and farmers congenital diseases.

The results of this study suggest that there is a need to conduct more in-depth studies by considering more diverse variables and using longitudinal methods to understand the long term impact of pesticide exposure on farmers. This is important to provide a more comprehensive picture and to formulate more effective interventions to protect farmers health.

CONCLUSION

Examination of *cholinesterase* enzyme levels in the blood of farmers found that most farmers had normal *cholinesterase* levels of 69.7% and 30.3% had abnormal *cholinesterase* enzyme levels. Most of the farmers used Carbamate pesticides, aged less than equal to 52 years, had a working period of less than equal to 31 years, spraying more than 2 times/ week u, educated $\geq$ junior high school, less good knowledge, and drinking water intake per day less than 2 liters. From the Correlation analysis, the determinants of the work of the *cholinesterase* enzyme include the type of pesticide, knowledge, frequency of spraying, tenure, and drinking water intake of farmers. This research is expected to contribute significantly to improving the health and safety of farmers exposed to pesticides, which in turn will support more sustainable agricultural practices.

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