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The Impact Of Pesticide Residue Accumulation On The Reduction Of Blood Cholinesterase Enzyme Levels In Dragon Fruit Farmers In Karo Land

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Abstract

Pesticide use has a negative impact on dragon fruit farmers. According to the World Health Organization (WHO), an estimated 1-5 million people experience pesticide poisoning annually, with a mortality rate of 220,000 deaths. Individuals experiencing pesticide poisoning will have low cholinesterase levels. This decreased enzyme activity can lead to nervous system disorders, poisoning, and even death. This study aimed to determine the effect of pesticide accumulation on the decline in cholinesterase enzyme levels among dragon fruit farmers in Berastepu Village, Tanah Karo. Blood samples were examined at the MCI Indonesia Clinical Laboratory. A descriptive approach was used in this study, with blood samples collected from dragon fruit farmers. The results showed that 11 farmers had normal cholinesterase levels, while 4 farmers had abnormal levels. The average values were normal (170.0-420 U/L) and abnormal (<170.0-420 U/L). The conclusion of the study with 15 samples was the cholinesterase levels in farmers who were exposed to pesticides 1-3 times a week with an age range of 31-40 years and 41-50 years.

Keywords: pesticides; farmers; cholinesterase enzyme; blood; dragon fruit.

1. Introduction

Dragon fruit (Hylocereus spp) is one of the leading horticultural commodities in Berastepu Village, Simpang Empat District, Tanah Karo due to its high market demand and promising economic value. Farmers generally use organophosphate pesticides intensively to achieve maximum dragon fruit production [11]. Uncontrolled pesticide use can leave chemical residues on plants, soil, and the bodies of farmers who are directly exposed. The accumulation of these pesticide residues has the potential to cause health problems for farmers and reduce the quality and safety of dragon fruit

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food produced. The lack of farmer awareness of the dangers of pesticide residues and the lack of supervision in the use of agricultural chemicals exacerbates this condition [1,2].

The majority of Karo people work as fruit, vegetable, and other horticultural farmers. Farmers use pesticides to care for, maintain, and increase agricultural yields. Commonly used pesticides are organophosphates. The use of organophosphate pesticides is often associated with poisoning incidents. Inappropriate use of pesticides in doses and frequencies, without personal protective equipment, can lead to the accumulation of pesticide residues in farmers' bodies through inhalation, skin contact, or consumption of contaminated food/drinks[10,9]. The prevalence of organophosphate pesticide poisoning worldwide reaches one million cases per year. Organophosphates inhibit blood levels of the cholinesterase enzyme. The cholinesterase enzyme in the body plays a crucial role in maintaining the balance of nerve, muscle, and glandular function, thus negatively impacting the health of farmers exposed to pesticides.

The use of unstandardized organophosphate pesticides causes chemicals to enter the body through the skin, oral cavity, and respiratory tract, thus disrupting health [3]. Organophosphate pesticides can inhibit the cholinesterase enzyme. The cholinesterase enzyme plays a crucial role in hydrolyzing acetylcholine into acetic acid and choline, which play a role in balancing nerve, muscle, and glandular function [9,10]. If this balance is disrupted, it can cause serious disorders such as tremors, headaches, heart problems, and coma [4]. The Indonesian Ministry of Health classifies cholinesterase activity into four criteria: normal (≥ 75-100% of normal), mild poisoning (≥ 50-75%), moderate poisoning (≥ 25-50%), and severe poisoning (≤ 25%) [5,6]. Therefore, research is needed regarding the impact of pesticide residue accumulation on the health of dragon fruit farmers by measuring the cholinesterase enzyme in the blood.

Risk factors associated with organophosphate pesticide poisoning include age, gender, knowledge, experience, skills, education, use of Personal Protective Equipment, nutritional status, and pesticide handling practices. Meanwhile, critical phases that must be considered are pesticide storage, pesticide mixing, pesticide use, and post-pesticide use. [9]. The majority of Karo people work as fruit, vegetable, and other horticultural farmers. Dragon fruit farmers use pesticides to care for, maintain, and increase their yields. Commonly used pesticides are organophosphates. The use of organophosphate pesticides is often associated with poisoning. The global prevalence of organophosphate pesticide poisoning reaches one million cases per year. Organophosphates inhibit blood levels of the cholinesterase enzyme. Cholinesterase plays a crucial role in maintaining the balance of nerve, muscle, and glandular function in the body, thus negatively impacting the health of farmers exposed to pesticides.

The increasing use of pesticides means that cases of poisoning will increase every year. When pests and weeds threaten crops, farmers use pesticides to remove them. The cholinesterase enzyme can function as a biomarker for pesticide toxicity. There are 466 farm workers in Central Java with cholinesterase levels that showed mild and severe poisoning. The use of spray pesticides releases toxic substances into the air and can be inhaled by farmers if they enter their bodies through the nose, causing chronic disease (Kurnadi, 2018). Cholinesterase is an enzyme found in the cytosol that hydrolyzes acetylcholine into inactive byproducts such as choline and acetic acid. For nerve impulses to reach their targets in muscle cells, the amount of active cholinesterase enzyme in

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plasma and red blood cells can be used as a marker of organophosphate poisoning. Organophosphate insecticides and carbabates are known to affect the cholinesterase enzyme. When diagnosing poisoning, the cholinesterase test uses a normal cholinesterase level value between 170 and 420 U/L.

2. Methods

This study aimed to determine whether dragon fruit farmers exposed to pesticides experience decreased cholinesterase levels through a laboratory-based descriptive research design. The focus was on the accumulation of pesticide residues and the reduction in cholinesterase enzyme levels among dragon fruit farmers in Tanah Karo.

Almost all residents of Berastepu, Tanah Karo, are dragon fruit farmers, and this was used for purposeful sampling (Purposive sampling was chosen because the researcher wanted to obtain respondents who met certain criteria in accordance with the research objectives, so that the data obtained was more relevant and able to describe the conditions being studied accurately).The samples used in this study were blood specimens from dragon fruit farmers selected according to inclusion and exclusion criteria, resulting in a total of 15 samples. (The sample size of 15 respondents was determined based on purposive sampling, taking into account uniformity of subject characteristics, compliance with inclusion criteria, and technical limitations of laboratory testing. This number was deemed adequate to describe the baseline conditions and trends of the biomarkers studied.)

Data collection and assessment tools were used in this study. The data collection instrument was an information questionnaire from dragon fruit farmers, while the examination instrument was a standard operating procedure (SOP) for cholinesterase examination. Cholinesterase levels were examined using the Automatic Fuji Film DRI-Chem NX5001 apparatus using blood samples. Data analysis used a quantitative method, conducted using an analytical survey using Excel, and the data were presented descriptively in tabular form.

3. Result and Discussion

RESULTS

The results of the cholinesterase level examination of dragon fruit farmers in Berastepu Village, Tanah Karo, who were exposed to pesticides, conducted at the MCI Medan Laboratory, are shown in Table 1.

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Table 1.
Cholinesterase Examination Results in Dragon Fruit Farmers in Berastepu Village

NO.	NAME	FEMALE	AGE	DRAGON FRIUT FARMERS	CHOLINESTERASE	DESCRIPTION
1.	S1	L	58	≥ 10	220	Normal
2.	S2	L	47	≥ 5	230	Normal
3.	S3	L	42	≥ 5	90	Decrease
4.	S4	P	37	≥ 3	22	Decrease
5.	S5	L	48	≥ 5	180	Normal
6.	S6	L	45	≥ 5	19	Decrease
7.	S7	L	40	≥ 5	405	Normal
8.	S8	L	31	≥ 3	317	Normal
9.	S9	P	48	≥ 5	344	Normal
10.	S10	L	36	≥ 3	140	Decrease
11.	S11	P	48	≥ 5	264	Normal
12.	S12	L	28	≥ 2	388	Normal
13.	S13	L	26	≥ 5	293	Normal
14.	S14	L	24	≥ 5	301	Normal
15.	S15	L	26	≥ 1	399	Normal

Table 1.Explains the total cholinesterase levels of dragon fruit farmers in Berastepu Village, Tanah Karo, showing that there are normal and abnormal levels with 15 dragon fruit farmers.

Table 2.

Results of Cholinesterase Percentage in Dragon Fruit Farmers in Berastepu Village, Tanah Karo

No.	Category	Farmers	Persentase (%)
1.	Normal (170,0 – 420,0 U/L)	11	73,3%
2.	Tidak Normal (< 170,0 – 420,0 U/L)	4	26,6%

In table 2, it was found that out of 15 dragon fruit farmers, 11 people had normal cholinesterase levels with a percentage of 73.3%, while 4 dragon fruit farmers had abnormal cholinesterase levels with a percentage of 26.6%.

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Table 3.
Characteristics of Dragon Fruit Farmers in Berastepu Village, Tanah Karo Based on Age

Age Category	Percentase (%)	Interpretation of Cholinesterase Levels
24 – 30	40 %	4 normal farmer
31 – 40	40 %	2 abnormal farmer, 2 normal farmer
41 – 50	50 %	2 abnormal farmer, 4 petani normal
51 – 60	10 %	1 normal farmer
Total	**100 %**	**15 farmer**

Age categories in this study were defined based on World Health Organization and Indonesian Ministry of Health classifications. Age was applied as a control variable to reduce biological confounding and ensure homogeneity among participants, rather than as a determinant of sample size. In table 3, it was obtained that with the age of 24-30 years, 4 farmers had normal cholinesterase levels (40%), aged 31-40 years with 2 farmers with abnormal levels, 2 farmers with normal cholinesterase levels (40%), 41-50 years with 2 farmers with abnormal levels, 4 farmers with normal cholinesterase levels (50%), 51-60 years with 1 normal farmer (10%). (Normal cholinesterase activity is defined as enzyme levels within the established reference range or ≥75% of baseline activity. A reduction below this level indicates enzyme inhibition due to pesticide exposure. Cholinesterase inhibition is classified as mild (50–74%), moderate (25–49%), or severe (<25%), reflecting increasing degrees of toxicological risk.

Table 4.
Characteristics of Dragon Fruit Farmers Based on Length of Service

Length of Servise	Precentase (%)	Interpret Cholinesterase Levels
1 – 5	93,33 %	4 abnormal farmer, 5 normal farmer
6 – 10	6,66 %	6 normal farmer

Length of service categories were established based on principles of occupational health and exposure epidemiology, with cut-offs of <5 years, 5–10 years, and >10 years reflecting increasing duration and accumulation of exposure, as used in various occupational health studies. It can be seen in Table 4 that dragon fruit farmers have worked for 1-5 years as dragon fruit farmers (93.33%) and 6-10 years as dragon fruit farmers (6.66%).

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Table 5.
Characteristics of Dragon Fruit Farmers Based on Spraying

Spraying	Percentase (%)	Interpret Levels	Cholinesterase
1 – 3 kali/minggu	100%	4 farmer abnormal 11 farmer normal	

In table 5, it was obtained that with a spraying frequency of 1-3 times a week, the cholinesterase levels of 4 farmers were abnormal, 11 farmers were normal (100%). (To minimize the influence of external factors, researchers conducted participant controls before, during, and after data collection. These efforts included establishing inclusion and exclusion criteria, standardizing examination times and procedures, providing pre-examination instructions regarding work activities and medication use, and recording activities and exposures as control variables in the analysis.

DISCUSSION

The study found that 95% of the farmers (11 farmers) had normal cholinesterase levels, while 5% (4 farmers) had abnormal cholinesterase levels. This demonstrates that the majority of dragon fruit farmers in Berastepu Village have cholinesterase levels within the normal range. However, many experience side effects from pesticides, including rashes, red eyes, and dizziness. Dragon fruit farmers in Berastepu Village, Tanah Karo, were interviewed and found to use various pesticides to control insect pests, with the active ingredient profenopos, a type of organophosphate pesticide.

In this study, farmers were interviewed and found to use a type of pesticide that can inhibit the work of the cholinesterase enzyme, although it is still within the normal value limit, but the farmers still feel some symptoms such as itching and headaches. From the results of the study, it was obtained that from 15 dragon fruit farmers, there were 11 people who had normal cholinesterase levels with a percentage of 73.3%, while 4 dragon fruit farmers had abnormal cholinesterase levels with a percentage of 26.6%. And it was obtained that with the age of 24-30 years, 4 farmers had normal cholinesterase levels (40%), 31-40 years old with 2 abnormal farmers, 2 farmers had normal cholinesterase levels (40%), 41-50 years old with 2 abnormal farmers, 4 farmers had normal cholinesterase levels (50%), 51-60 years old 1 normal farmer (10%).

If the pesticide residue of profenopos contained in dragon fruit is swallowed, it can cause effects on the health of consumers that are not immediately felt but over time cause disorders in the nervous system, liver, stomach and digestive tract, seizures, nausea, headaches, abdominal cramps and chest tightness. Obtained 170.0 - 420.0 U / L with 11 farmers 73.3% normal and <170.0 -420.0 U / L there are 4 farmers with cholinesterase levels decreased by 26.6%. This proves that both from the young and old age categories the cholinesterase levels due to farmer activities in the field are not much different.

Based on the research obtained with the age of 24-30 years 4 farmers with normal cholinesterase levels (40%), age 31-40 years with 2 farmers are not normal, 2 farmers normal cholinesterase levels (40%), 41-50 years with 2 farmers are not normal, 4 farmers normal

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cholinesterase levels (50%), 51-60 years 1 normal farmer (10%). And that the dragon fruit farmers have a work period of 1-5 years as dragon fruit farmers (93.33%) and 6-10 years as dragon fruit farmers (6.66%). With the decrease in cholinesterase levels due to the frequency of spraying is not certain 1-3 times / week and some farmers only work as fruit harvesters or clearing wild plants, so that the level of poison from pesticides that enter the body is quite a lot and makes cholinesterase levels decrease.

This aligns with research (Afriyani, 2018), which states that the longer a farmer works in direct contact with pesticides, the more chemicals from the pesticides enter and accumulate in their bodies. When it rains, dragon fruit farmers do not spray, so some dragon fruit farmers' cholinesterase levels remain normal. If it rains in the morning, farmers spray in the afternoon, and the spraying can last for five hours. The longer the spraying time, the greater the impact of pesticide exposure on farmers.

Dragon fruit farmers with five years of experience have decreased cholinesterase levels (<170.0-420 U/L) due to accumulation in their bodies. The longer farmers continue to spray, the greater the risk of chemical poisoning. This study found that four dragon fruit farmers had decreased cholinesterase levels due to long working hours compared to 11 other dragon fruit farmers. The longer dragon fruit farmers are exposed to pesticides, the greater the accumulation of pesticide residues in their bodies, ultimately lowering blood cholinesterase levels.

Blood cholinesterase enzyme activity is measured to determine pesticide exposure and it should be remembered that it is caused by a number of disorders, especially liver disease, severe hepatitis-cirrhosis and acute and chronic liver tumors (Pratuna, 2018).

4. Conclusion

CONCLUSION

A study of blood cholinesterase enzyme levels in dragon fruit farmers after pesticide exposure in Berastepu Village, Tanah Karo, found 11 farmers with normal cholinesterase levels and 4 farmers with decreased cholinesterase levels, with a decrease of 19-140 U/L, below the normal limit of <170.0–240.0 U/L. The more frequent spraying without personal protective equipment, the greater the exposure to pesticides.

SUGGESTIONS

Based on the conclusions obtained from blood cholinesterase level tests on dragon fruit farmers in Berastepu Village, Tanah Karo, the authors recommend:

1. Avoid direct contact with the pesticides used when spraying. Wearing personal protective equipment can reduce exposure.
2. Farmers should undergo regular health checks to assess the long-term impacts of pesticide use and the health risks.
3. Future researchers can conduct cholinesterase level tests on fruit farmers using different methods and tools to determine the potential impact of other test results.

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