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RESEARCH **Open Access**

Pesticide Exposure and Increased Liver Enzyme Activity among Suburban Horticultural

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Abstract

Horticultural farmers use chemicals such as pesticides to increase productivity and product quality. Exposure to pesticides can cause health problems, especially in the liver. A reference for evaluating liver function is blood test results for ALT, AST, ALP, and GGT activity. This study aimed to characterize the transaminase enzyme activity in horticultural farmers in the southern ring road area of Jambi City based on the risk factors associated with pesticide exposure. This study employed a cross-sectional study approach in conjunction with a descriptive method. Thirty-four participants were involved, and blood samples were obtained from each for analysis in a lab. A photometer was utilized in the Medical Laboratory Technology department at Health Polytechnic of Jambi to measure the activity of liver enzymes. This study found some respondents who experienced increased enzyme activity, namely ALT: 8 people (23.5%), AST: 3 people (8.8%), ALP: 1 person (2.9%), and GGT: 1 person (2.9%.). Based on the risk description observed, it was known that the intensity of pesticide exposure showed a significant increase only in ALT enzyme activity (p=0.0048), while adherence to mask-wearing increased ALT (p=0.0018) and GGT (p=0.0134). This study discovered that wearing a mask and the amount of pesticide exposure can increase enzyme activity, which may indicate liver impairment in the horticultural farmers under observation. Workers are expected to pay greater attention to workplace safety by wearing masks and applying pesticides in the recommended dosages.

Keywords: Horticultural Farmers, Pesticide, Liver Enzyme Activity.

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1. INTRODUCTION

Indonesia is a productive country in the agricultural sector. Horticulture is one of the commodities produced by this sector. Since horticulture has easily damaged characteristics, managing pests and plant diseases significantly impacts productivity (Amilia, Joy, and Sunardi., 2016). In reality, a large number of horticultural farmers continue to use excessive amounts of chemicals, such as pesticides, to enhance yields and product quality, which can have adverse effects on health (Agustina & Norfai, 2018; Hassaan & El Nemr, 2020; Mrema et al., 2017).

According to data from the World Health Organization (WHO), there are between one and five million cases of poisoning among agricultural labourers annually, varying in severity and potentially affecting vital organs like the kidneys, lungs, or heart. An estimated 11,000 people die globally each year as a result of unintentional pesticide poisoning (Boedeker et al., 2020; Tostado & Bollmohr, 2022). Meanwhile, the Food and Drug Supervisory Agency reported that there were 344 cases of pesticide poisoning in Indonesia in 2019; 41.7% of those cases were associated with agricultural pesticides (BPOM, 2020)

Pesticides are generally absorbed by farmers through inhalation, digestion, or dermal and distributed through the circulatory system to affect various organs, particularly the liver and kidneys involved in detoxification. This exposure condition may adversely affect The farmers' health (Boedeker et al., 2020; Jamal et al., 2015). ALT (alanine aminotransferase), also known as SGPT (serum glutamic Pyruvic transaminase), AST (aspartate aminotransferase), also known as SGOT (serum glutamic Oxaloacetic transaminase), GGT (gamma-glutamyl transaminase), and ALP (alkaline phosphatase), are manifestations of the enzymes connected to these organs and can be utilized to demonstrate the presence of liver dysfunction (Lala et al., 2022). A picture of the health of their livers was intended to be obtained by measuring the activity of these enzymes in horticultural farmers in Jambi City's South Rim neighbourhood who frequently come into contact with pesticides at work.

The analysis used the following criteria: how long the research participants had been farmers, how frequently they implemented pesticides at work, and whether they employed masks or personal protective equipment to protect themselves from herbicide and insecticide exposure while spraying pesticides. These studies were conducted to examine farmers' attitudes and practices regarding the use of pesticides and their elevated enzyme activities, which are considered an index marker of hepatotoxicity.

2. RESEARCH METHOD

Descriptive research utilizing a cross-sectional approach is the methodology employed. In Paal Merah, Jambi's Lingkar Selatan Village, sampling was conducted. The clinical chemistry laboratory of the Department of Medical Laboratory Technology at Health Polytechnic of Jambi is where the activity of the enzymes ALT, AST, ALP, and GGT was evaluated. Horticultural farmers in Jambi's Lingkar Selatan Paalmerah Village who employed herbicides and insecticides contributed to the study's sample. Thirty-four farmers who belonged to Gapoktan Tani Makmur were the samples employed for this study. Purposive sampling was utilized, and 10 to 14 willing respondents from each group were selected to constitute the sample. The Health Polytechnic of Jambi's Research Ethics Committee granted ethical approval for this study, with approval number LB.02.06/2/353/2022.

Blood specimens from each subject were taken using a closed system with a yellow lid vacutainer tube filled with a gel separator. The frozen blood was centrifuged for five minutes to extract serum for testing at 3000 RPM. Using BioSystems reagent and the BTS-350 semi-automatic photometer, the kinetic method was used to measure the activity of the enzymes ALT, AST, ALP, and GGT.

After the enzyme activity was determined, the data was examined to discover how it related to the respondents' attributes, particularly those directly connected to their risk of pesticide exposure. The average value of enzyme activity and the frequency, or percentage, of high enzyme activity detected are displayed in tabulations and graphs containing the data. Different statistical tests (ANOVA and independent t-test) were performed using Medcalc ver. 19.0.7 for Windows with a significance level of 0.05.

3. RESULTS AND DISCUSSION

Table 1. Characteristics of demographic and enzyme activity test results

Characteristics		**Total**	**Percentage**
Gender	Male	22	64.7%
	Female	12	35.3%
Age	Mean (± SD) *	41.6	(± 10.8)
	Adult	18	52.9%
	Pre-elderly	14	41.2%
	Elderly	2	5.9%
Length of time as a farmer	Mean (± SD) *	14.8	(± 8.7)
	<10 years	12	35.3%
	11-20 years	12	35.3%
	>20 years	10	29.4%
Intensity of pesticide using	Very rarely	15	44.1%
	Rarely	13	38.2%
	Often	6	17.6%
Mask-wearing adherence	Very rarely	2	5.9%
	Rarely	9	26.5%
	Always	23	67.6%
Alanine transaminase (ALT)	Mean (± SD) *	30.3	(± 16.4)
	Normal	26	76.5%
	High	8	23.5%
Aspartate transaminase (AST)	Mean (± SD) *	23.6	(± 8.6)
	Normal	31	91.2%
	High	3	8.8%
Alkaline Phosphatase (ALP)	Mean (± SD) *	70.2	(± 25.1)
	Normal	33	97.1%
	High	1	2.9%
Gamma-glutamyl transferase (GGT)	Mean (± SD) *	22.7	(± 12.8)
	Normal	31	91.2%
	High	1	2.9%

** Mean and standard deviation (enzyme activity in IU/L; age & length of being a farmer in years)*

The study's samples' clinical laboratory and demographic characteristics are displayed in Table 1. The Indonesian Ministry of Health categorized age characteristics into three groups: adults (19–44 years), pre-elderly (45–60 years), and elderly (>60 years) (Dahlan et al., 2018). The duration of employment as a farmer was also classified into three groups according to the respondents' statements about their initial horticultural employment date. The predefined range in this study is every ten years. The frequency with which respondents administered pesticides while at work was divided into three categories: very rare (less than three times per month), rare (one to two times per week), and frequent (more than two times per week). Furthermore, data were also obtained on the level of respondents' compliance in wearing a good mask as a piece of personal protective equipment (PPE) when spraying pesticides in the categories of very rarely (never or only occasionally wearing a mask), rarely (sometimes wearing a mask), and often (almost always or always wearing a mask).

Table 1 illustrates that most respondents are male, with mature and pre-elderly criteria. The respondents' duration of farming is equitably distributed according to the three observed criteria. Based on the description of the spraying intensity and the use of masks obtained, most respondents also had a relatively low risk of pesticide exposure. The average value of the test results for each observed laboratory parameter is also provided, and it is still within the normal range. The graph in Figure 1 below demonstrates how each enzyme activity test result was distributed among the 34 horticultural farmer respondents who were observed.

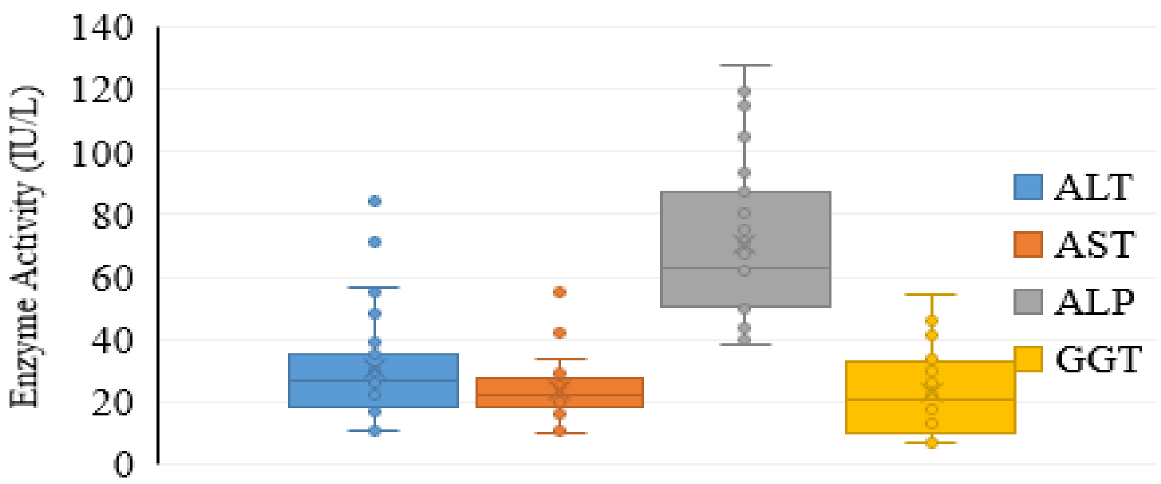

Figure 1. Boxplot graph of the results of measuring enzyme activity in horticultural farmers' liver function tests

Most of the findings from the analysis of the four enzyme activities identified in this investigation decreased within the typical range for each parameter. Lala et al. (2022) provided the expected values for this study, which are as follows: GGT: 6-50 IU/L; AST: 5-30 IU/L; ALP: 30-120 IU/L; and ALT: 4-36 IU/L. Various frequencies of enzyme activity descending into the high category (exceeding the standard value) were observed for each enzyme test parameter. The most significant proportion was identified in 8 respondents (23.5%) with high ALT activity test parameter results. ALP had one respondent (2.9%), GGT had one respondent (2.9%), and AST had three (8.8%) respondents. In the meantime, these were the other three parameters.

Based on the demographic features of the study participants, the percentage of high-activity events in the observed four enzymes was subsequently examined (figure 2). The respondents who did not wear protective equipment (PPE) included individuals with high ALT and AST activities. In contrast to variations from other characteristics, respondents with the characteristic of the intensity of pesticide spraying that was included in the frequent category had the highest percentage of high ALP and GGT enzyme activities. Based on the characteristics of each respondent group examined in this study, overall, ALT has the highest percentage compared to other parameters.

Toxic chemical compounds can enter the human body in several ways, encompassing absorption through the skin, orally, or inhalation, intentionally or unintentionally. These dangerous materials are a potential workplace risk for many different professions worldwide. The detrimental effects of pesticide exposure on liver disorders, which are in charge of neutralizing dangerous substances that enter the body, have been documented in several long-running studies (Colombo et al., 2019; Luo et al., 2005; Malaguarnera, 2012; Redlich, 1988). Prospective cohort studies have also reported discussions regarding different pesticide types affecting human health. These studies state that, despite not having a high and consistent potential, this hazardous material is predicted to be one of the triggers of cancer in a person, involving bladder and liver cancer (Koutros et al., 2016; Rapisarda et al., 2016; VoPham et al., 2017).

Studies on various types of farmers have also reported pesticide exposure. The liver eventually suffers chronic damage from the accumulation of this exposure (Melaram, 2021; Damalas & Koutroubas, 2016). Based on the study's analysis of the respondents' demographic features, the percentage of high activity occurrence in each of the identified four enzymes was further examined (Figure 2). The "rarely" category of respondents' mask-wearing compliance displayed the highest percentage (100%) for the ALT and AST parameters. In contrast to other risk variations or characteristics, the highest percentage (50%) of respondents with pesticide spraying intensity in the "frequent" category had high activity of ALP and GGT enzymes.

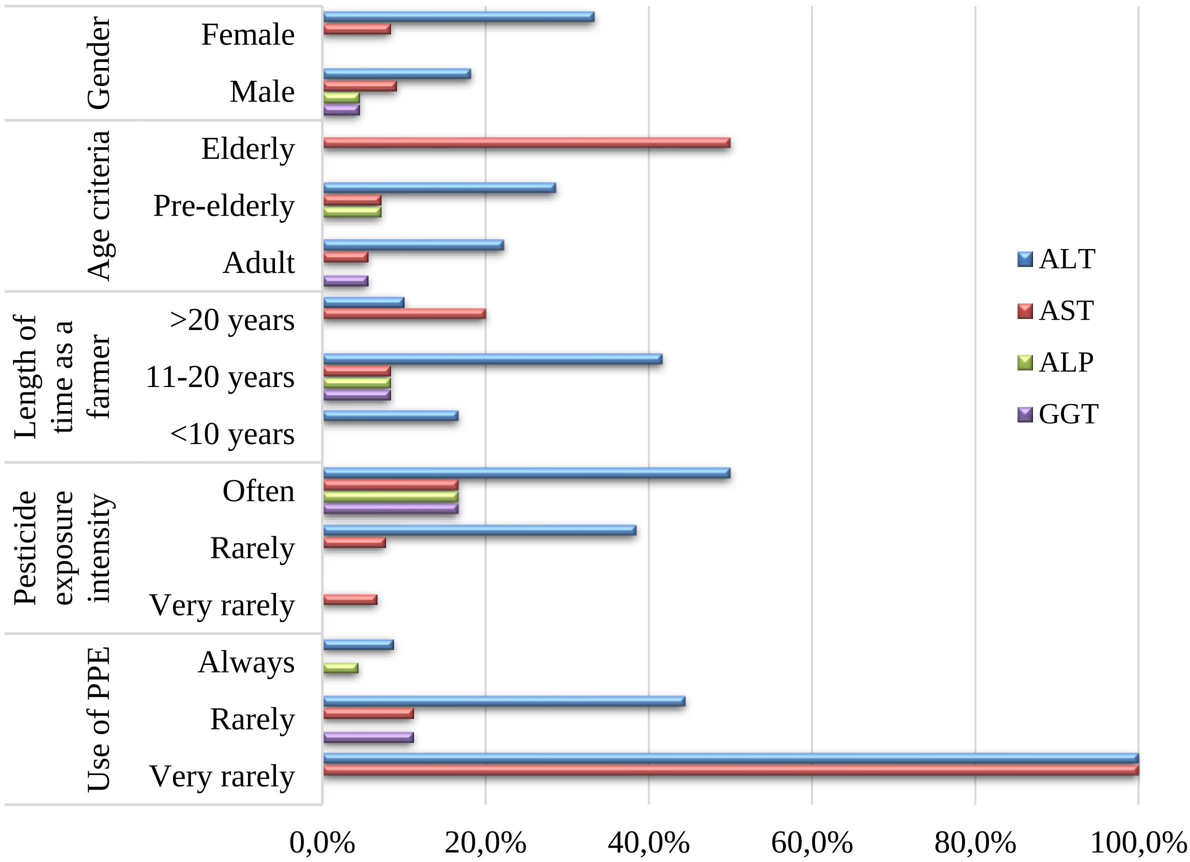

Figure 2. Graph of the percentage of high enzyme activity based on the characteristics of horticultural farmers.

Statistical analysis was administered to show differences in the results of the four parameters of measurement of enzyme activity based on each variable group of respondent characteristics. There were no discernible differences between the respondents' age, gender, or length of time employed as farmers for any of the enzyme activities. As stated differently, no increase in enzyme activity was observed among the respondents as a result of these three variables. There was a difference in the ALT enzyme activity measurements according to the degree of pesticide exposure (p=0.0048) and farmers' adherence to wearing masks when spraying (p=0.0018). Furthermore, this significance was also demonstrated by the GGT enzyme activity, but only in the variable mask use (p=0.0134). In contrast, AST and ALP activities did not provide a significant difference in each of the variations of these two variables.

Table 2. Analysis of the characteristics of farmers on the results of enzyme activity tests.

Characteristic	**ALT**			**AST**			**ALP**			**GGT**		
	N	**H**	**Mean**	**N**	**H**	**Mean**	**N**	**H**	**Mean**	**N**	**T**	**Mean**
Gender												
Male	18	4	27.3	20	2	23.3	21	1	69.5	21	1	20.7
Female	8	4	35.8	11	1	24.2	12	0	72.1	12	0	26.4
p-value			0.125			0.3295			0.705			0.1251
Age group												
Adult	14	4	29.7	17	1	21.7	18	0	73.3	17	1	21.5
Pre-elderly	10	4	32.4	13	1	24.9	13	1	66.1	14	0	23.9
Elderly	2	0	21	1	1	32	2	0	74.5	2	0	25.5
p-value			0.6511			0.2173			0.7307			0.8354
Length of time as a farmer												
<10 years	10	2	29	12	0	20.7	12	0	74.1	12	0	20.2
11-20 years	7	5	35	11	1	23.3	11	1	69.5	11	1	26.3
>20 years	9	1	26.2	8	2	27.4	10	0	67.1	10	0	25.1
p-value			0.4456			0.1917			0.819			0.4822
Intensity of pesticide-using												
Very rarely	15	0	21.4	14	1	20.7	15	0	67.3	15	0	17.9
Rarely	8	5	33.9	12	1	25.7	13	0	73.5	13	0	25.9
Often	3	3	44.7	5	1	27.5	5	1	71.9	5	1	27.8
p-value			0.0048**			0.1138			0.8206			0.1462
Mask-wearing adherence												
Very rarely	0	2	25.3	0	2	21.5	2	0	69.4	2	0	19.2
Rarely	5	4	35.8	8	1	28.2	9	0	69.4	8	1	27.1
Always	21	2	63	23	0	26.5	22	1	87.2	23	0	43.5
p-value			0.0018**			0.1252			0.6496			0.0134*

*Note: N = number of respondents with normal enzyme activity; H = the number of respondents with high enzyme activity; Mean= average value of enzyme activity (IU/L); P-value is significant at the level of: *= 0.05 & **= 0.01*

In comparison to other parameters, overall, ALT is also the one that frequently demonstrates the highest percentage, particularly when it comes to respondent characteristics associated with pesticide exposure risk factors. Although pesticide poisoning also increases other enzyme activities present in farmers' blood, this is very consistent with the phenomenon found in several previous studies in several countries that showed an increase in the same enzyme in cases of pesticide poisoning (Damalas & Koutroubas, 2016; Freire et al., 2015; Jamal et al., 2015). When Lozano-Paniagua et al. (2021) observed greenhouse farmers in Spain who were exposed to pesticides, they discovered that workers who had high exposure periods had higher levels of ALT and ALP. Bernieri et al. (2021) observed that although AST enzyme activity increased significantly following high pesticide exposure in Brazilian farmers, ALT and GGT did not increase. In the past, Manfo et al. (2020) used a case-control methodology to track the prevalence of kidney and liver diseases among farmers in Buea, Cameroon. The study revealed that exposure to pesticides increased the activity of the ALT enzyme significantly but not that of the AST, creatinine, or uric acid. Nevertheless, because the majority of these enzymes are produced in the liver (hepatic cells), ALT is recognized as the most specific enzyme to indicate impaired liver function when compared to other enzymes (Aulbach & Amuzie, 2017).

Freire et al. (2015), who observed Brazilians who were heavily exposed to organochlorine pesticides, also gathered that there was an increase in liver enzyme activity due to these compounds. Moreover, other parameters, such as bilirubin, which is also the primary marker of liver function abnormalities, were successfully evidenced to possess a significant relationship with beta-hexachlorocyclohexane levels unveiled in the blood of respondents. Furthermore, from the hematological aspect, eosinophilia was also reported, as well as decreased hemoglobin levels and erythrocyte counts in the blood.

Several factors, including age, length of employment, use of personal protective equipment (PPE), pesticide dosage, wind direction during spraying, and frequency of spraying, can affect how severe liver function disorders caused by pesticide exposure can be. Because farmers are more susceptible to coming into direct contact with pesticides, including both herbicides and insecticides, the length of time they work can raise their risk of pesticide poisoning (Andarini & Rosanti, 2018). Farmers frequently disregard the importance of wearing personal protective equipment (PPE), such as masks, even though it can lessen the adverse health effects of pesticide exposure. Numerous studies conducted on lab animals have demonstrated the hepatotoxic effects of pesticides (Nieradko-Iwanicka & Borzęcki, 2015; Rizzati et al., 2016). Meanwhile, Yokoyama et al. (2019) asserted that exposure to pesticides provided to animals tested in his study did not cause an increase in ALP enzyme activity. This is similar to the facts uncovered in this study on ALP enzyme activity, which also did not show any significant difference between the risk groups observed.

Bayili et al. (2020) performed a longitudinal study on 113 farmers in two phases: the first phase occurred during the harvest period, and the second phase was conducted six months after the harvest period ended. The second phase's ALT and AST activity significantly decreased ($p<0.01$), according to the results. Although ALP's average value decreased as well, there was no discernible change. On the other hand, GGT activity rose from 40.5 ± 30.68 U/L in the first phase to 63.0 ± 67.07 U/L in the second phase ($p < 0.0001$). This demonstrates how heavily farmers' exposure to pesticides during their work affects abnormalities in liver function; the less intensely farmers are exposed, the lower the results of the measurement of liver enzyme activity that exceeds typical values.

In a study conducted in Indonesia, Sukmayanti et al. (2020) concluded that gender and age affect ALT and cholinesterase enzyme activity. Male farmers in Bali's Tabanan district had higher levels of enzyme activity than female farmers, according to observations made of them growing vegetables. This contrasts with the phenomenon uncovered when ALT activity was measured in farmers in Jambi City's South Ring, where nearly all of the enzymes discovered had mean values that were higher in the female group than the male group. In the same way, the researchers identified no statistically significant differences in the age group of farmers in this study, even though the observed enzyme activity values in the South Ring of Jambi City tended to increase with farmer age.

Meanwhile, research conducted by Tsani et al. (2017) revealed that 29 out of 43 farmers (67.4%) in Sumberejo village, Magelang, had impaired liver function. The study ultimately concluded that a working period could have an impact on liver function impairment and lead to an accumulation of pesticides in the body. It was determined that there is little correlation between PPE use and the prevalence of liver function disorders. This is conceivable because there was only one farmer respondent in the study who fully utilized PPE. The results of a study on farmers in Jambi City's South Ring demonstrate a lower percentage—just 9 out of 34 farmers, or 26.5 per cent. Since the length of service as a farmer generated no statistically significant results in this study, it can be assumed that it is not a significant factor in determining the onset of liver function disorders. The high intensity of pesticide use, which is not followed by the use of suitable PPE, is proven to cause the accumulation of pesticides in the body to increase and cause impaired liver function.

4. CONCLUSION

According to this study, nine out of the horticultural farmers who used pesticides (26.5%) within the southern ring road of Jambi City had high enzyme measurement results. The most frequently encountered enzyme with elevated activity above normal values was alanine aminotransferase (ALT). This study has demonstrated that the intensity of pesticide spraying and mask use by horticultural farmers are risk factors that may lead to elevated liver enzyme activity, particularly ALT and GGT.

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