

THE EFFECTS OF ORGANOPHOSPHATE PESTICIDES EXPOSURE TO LIVER FUNCTION AND CHOLINESTERASE SERUM ACTIVITY AMONG APPLE GROWERS APPLYING PESTICIDES

Iwan Desimal*, Jojok Mukono**

*Environmental Health Program, Faculty of Public Health, Airlangga University

**Department of Environmental Health, Faculty of Public Health, Airlangga University

Correspondency:

Department of Environmental Health, Faculty of Public Health, Airlangga University

Kampus C Unair Jl.Mulyorejo Surabaya– 60115

Email: mukono_j@yahoo.com

ABSTRACT

Organophosphate pesticides are the most commonly used insecticides in developing country such as Indonesia. The research location is the center of apple plantation from which its title the City of Apple originated. The use of pesticides can harm one's health, for instance inhibiting serum cholinesterase activities and impairs liver function in the long run. Diagnosis administered to detect liver damage is liver function test (LFTs) which measures elevated liver enzymes indicating liver damage like Serum Glutamic Pyruvic Transaminase (SGPT), Alkaline Phosphatase (ALP), Gamma Glutamic Transferase (GGT). The research aims to analyze the effects of organophosphate pesticides exposures on cholinesterase serum activity as well as liver function among apple growers who work with pesticides. The research is an observational study using cross sectional approach. A total of 40 samples were sorted into two groups, 20 samples were exposed to pesticides while the other 20 samples were not exposed to pesticides. The samples were then analyzed using multi linear regression technique. The result shows a correlation between the use of improper dose of pesticides and cholinesterase activity ($p < 0.05$). Liver function test (LFTs) shows a correlation between pesticides dose and spraying frequency and the activity of Serum Glutamic Pyruvic Transaminase/SGPT ($p < 0.5$). Higher dose and variety of the pesticides' types shall lower the cholinesterase serum activity. The conclusion show that the dose, type of poisoning, and hours of exposure can raise enzymes activity indicating liver function damage. Consequently, need of more supervision and technical guidance from the Agriculture Office as well as Health Office on the safe procedure of pesticides. The importance of the package's label before its use and the use of protective clothing and equipment (PCE).

Keywords: *organophosphate, pesticides exposure, cholinesterase serum, liver function and pesticides sprayer*

INTRODUCTION

Agricultural sector has a profound contribution to social welfare. In practice agrochemicals have been widely used in order to increase agricultural productivity. In this case pesticides are considered the most-widely used agrochemicals replacing the old technology of pest control and fertilizers (Priyanto, 2009).

There are three types of pesticides widely used in the agricultural sector (Soemirat, 2009). Organophosphate (OP)

pesticides are the most highly used in Indonesia (Priyanto, 2009). One farming region in Indonesia use the pesticides is the City of Batu which produces vegetables and fruits. Apples are notably common in Batu making it the City of Apple of the country. Pesticides have been used as a way to increase agricultural productivity, which on the other hand leads to health problems.

In 2011–2012, Batu's Health Office administered cholinesterase enzyme test on 330 farmers in three sub-districts of Batu,

Bumiaji and Junrejo. The result shows a rise in poisoning level in 2011–2012 with the exception of severe poisoning (Profil Kota Batu 2011). One of the areas with rising farming activity is sub-district of Bumiaji, especially rural Bumiaji. An official record of Agriculture Office of Bumiaji reveals the use of Antracol as the most frequently used pesticides. This type was used everywhere in sub-district of Batu encompassing Bumiaji, Junrejo and Batu. Other brands include *Curacron*, *Dursban*, and *Proplin*. Curacilin and Dursban are considered frequently used OP pesticides.

Organophosphates are the most toxic to humans and insecticides causing poisoning (Lubis, 2002). Organophosphate pesticides can be ingested or inhaled or absorbed through the skin (Clyde, et al., 2012; Mukono, 2010). Symptoms that follow the use of OP pesticides include the decreasing of cholinesterase enzyme activity. Cholinesterase enzymes regulate muscles, glands and nerve cells as to function in harmony (Sawiendrayanti dkk, 2012).

Long term accumulation of pesticides leads to damage of the liver as the organ for biotransformation of poison. Liver function problems due to organophosphate pesticides will turn up in the enzymes excreted in the blood. The research conducted by Hashmi, et al (2010) in Pakistan showed that the levels of *Serum Glutamic Oxaloacetic Transaminase*/SGOT, *Serum Glutamic Pyruvic Transaminase*/SGPT, and *Alkaline Phosphatase*/ALP were higher in the pesticides-exposed group. The same type of research was also carried out by Shahida (2008) measuring the levels of SGPT, SGOT, ALP as well as *Gamma Glutamyl Transferase*/GGT enzymes due to OP pesticides exposure in Sindh Province, Pakistan.

The risk populations as a result of OP pesticides exposure are farmers applying the OP pesticides. The typical activities are preparing the materials, mixing the pesticides, applying the pesticides, washing

the equipments or clothing used in the activity.

METHODS

In general present research aims to analyze the effects of OP pesticide exposure on cholinesterase serum activity and liver function among apple growers applying the OP pesticides in rural Bumiaji sub-district of Bumiaji the City of Batu.

Research type is observational analytical using cross sectional approach. Populations of research consist of all villagers living in Bumiaji with total samples of 40 persons. The samples were retrospectively divided into two groups where 20 samples are pesticides sprayers (exposed group) while the rest consisted of non pesticides sprayers (unexposed group). All samples live in rural Bumiaji sub-district of Bumiaji in the City of Batu. Samples were recruited through the use of simple random sampling.

Independent variables include dose, hours of exposure, working hours, application frequency, and the proper use of protective clothing and equipments (PCE). As dependent variables are cholinesterase serum activity and liver function which include *Serum Glutamic*

Pyruvic Transaminase (SGPT), *Alkaline Phosphatase* (ALP) and *Gamma Glutamyl Transferase* (GGT)'s activities.

Primary data employed in research obtained through interview using questionnaire besides laboratory result of *Serum Glutamic Pyruvic Transaminase* (SGPT), *Alkaline Phosphatase* (ALP) dan *Gamma Glutamyl Transferase* (GGT)'s activities conducted at Kimia Farma Laboratory Malang. Secondary data were taken from Rural Monograph year 2012.

Data were analyzed using multiple linear regression technique in order to see the effects of independent variables on dependent variables. The result of the test was compared with the actual significance level of 5%.

RESULT AND DISCUSSION

The Effects of OP Pesticides Exposure on Cholinesterase Serum Activity.

OP pesticides exposure covers dose, amount of pesticides, spraying frequency, working hours, application frequency and the proper use of protective clothing and equipments (PCE).

Dose

Unrecommended pesticides dose has adverse effects on cholinesterase serum activity. Unrecommended pesticides dose may cause poisoning among farmers (Djau, 2009). Unrecommended dose is usually implemented by growers in order to achieve maximum result in pest control as well as plant growth oftenly by adding the unrecommended dosage. The finding is consistent with a previous study conducted by Marsaulina and Wahyuni (2007) stating that there was a correlation between the dose and poisoning with Odd Ratio Value of 2,6. Afriyanto (2008) confirms that the risk of poisoning caused by unrecommended dose is four times higher compared to recommended dose procedure.

Table 1. The analysis result on the effects of pesticides dose, pesticides amount, spraying frequency, working hours, application frequency, and the proper use of protective clothing and equipments (PCE) on cholinesterase serum activity

Dependent Variable	Independent Variables	p
Cholinesterase Serum	Recommended dose	–
	Unrecommended dose	0,015*
	Amount of pesticides	0,037*
	Spraying frequency	0,182**
	Working hours	0,414**
	Application frequency	0,116**
	Proper use of PCE	0,358**
	Improper use of PCE	0,215**

Annotation: * = significant
** = insignificant

Pesticides amount

The amount of pesticides used has dire effect on cholinesterase serum activity. The use of several types of pesticides in single application can cause poisoning enhanced through synergic reaction of active substances contained in the various pesticides (Djau, 2009). Growers applying > 1 type pesticide having abnormal cholinesterase in their blood are 4.68 higher than those who use 1 type of pesticides (Afriyanto, 2008). Reserach reveals that 40% of farmers use as many as 3 types of pesticides in single application.

Spraying frequency

Spraying frequency does not affect cholinesterase serum activity. The longer spraying activity, the higher are toxication rate cases. Research shows that hours of applying the pesticides among the growers are 2–3 hours/day (30% respondents). However it is associated with the size of the fields. Larger fields require longer spraying. Application ≥ 3 hours/day causes mild poisoning (Runia, 2008). According to the study by Afriyanto (2008) growers with hours of pesticides spraying > 3 hours/day risk cholinesterase activity inhibition 4.24 times higher than those who do < 3 hours/day in single application.

Working hours

Working hours shows no effect on cholinesterase serum activity. Based on the research, average working hours are 6 hours per day (35% of respondents). Growers who work too long with pesticides will experience chronic poisoning, meaning the poisoning is accumulating over time and lowering cholinesterase activity as the result (Rustia, 2009).

Spraying frequency

Spraying frequency shows no adverse effects on cholinesterase serum activity. This is in contrast with another finding by Handojo (2001) arguing that spraying

frequency affects cholinesterase activity with probability value < 0.05. Based on the research, spraying frequency is twice a week, which is considered normal. Recommended hours for farmers to work with pesticides are not more than twice in a week (Afriyanto, 2008).

Appropriate Use of Protective Clothing and Equipments (PCE).

Appropriate use of PCE shows no effects on cholinesterase serum activity. The finding contradicts previous studies by Tampudu et all. (2010), Faziah (2002), Hermawan et all. (2013) conducted upon growers applying pesticides stating that appropriate use of PCE strongly correlates with the decline in cholinesterase enzyme activity. The argument was confirmed by Afriyanto (2008) stating that 50% of the

respondents without PCE, increasing the risk to suffer pesticides poisoning.

The Effects of OP Pesticides on Liver Function (*Serum Glutamic Pyruvic Transaminase/SGPT, Alkaline Phosphatase/ALP and Gamma Glutamyl Transferase/GGT*)

Dose

Pesticides dose, either recommended or unrecommended, does not have any effects on SGPT, ALP, GGT activities. Real life application reveals that 70% of farmers applying pesticides according to recommended procedure do so due to pesticides' high cost.

Pesticides amount

Pesticides amount has adverse effect on SGPT activity, but not on ALP and GGT

Table 2. Analysis result on the effects of pesticides dose, pesticides amount, spraying hours, working hours, spraying frequency and appropriate use of protective clothing and equipments (PCE) against *Serum Glutamic Pyruvic Transaminase/SGPT's* activity

Dependent variable	Independent variables	p
<i>Serum Glutamic Pyruvic Transaminase/SGPT</i>	Recommended dose	–
	Unrecommended dose	0.354**
	Pesticides amount	0.019*
	Spraying hours	0.046*
	Working hours	0.412**
	Spraying frequency	0.921**
	Appropriate use of PCE	0.198**
	Inappropriate use of PCE	0.460**

Annotation: * = significant
** = insignificant

Table 3. Analysis result on the effects of pesticides dose, pesticides amount, spraying hours, working hours, spraying frequency and appropriate use of protective clothing and equipments (PCE) against *Alkaline Phosphatase/ALP's* activity.

Dependent variable	Independent variables	p
<i>Alkaline Phosphatase/ALP</i>	Recommended dose	–
	Unrecommended dose	0.415**
	Pesticides amount	0.667**
	Spraying hours	0.315**
	Working hours	0.795**
	Spraying frequency	0.827**
	Appropriate use of PCE	0.947**
	Inappropriate use of PCE	0.481**

Annotation: * = significant
** = insignificant

Table 4. Analysis result on the effects of pesticides dose, pesticides amount, spraying hours, working hours, spraying frequency and appropriate use of protective clothing and equipments (PCE) against *Gamma Glutamyl Transferase* (GGT's) activity.

Dependent variable	Independent variables	p
<i>Gamma Glutamyl Transferase</i> /GGT	Recommended dose	–
	Unrecommended dose	0.599**
	Pesticides amount	0.494**
	Spraying hours	0.625**
	Working hours	0.206**
	Spraying frequency	0.855**
	Appropriate use of PCE	0.241**
	Inappropriate use of PCE	0.183**

Annotation: * = significant
** = insignificant

activities. Based on research which used at least two types of OP pesticides in single spraying. Each type has different toxicity level depending on the active substance therein. In real life situation, farmers tend to use OP pesticides with active substance of methamidophos. Methamidophos is classified as class 1 compound which means highly toxic organophosphate (*Environmental Protection Agency*/EPA in Azmi, et al., 2009).

Spraying hours

OP pesticides' spraying hours affects SGPT activity, but do not affect ALP and GGT activities. The longer the spraying hours, the more poison absorbed by the body leading to liver function problem, notably SGPT enzyme.

Working hours

Working hours does not affect SGPT, ALP and GGT activities. Average working

hours of the farmers is 6 hours per day, which is considered to be normal.

Spraying frequency

Spraying frequency does not affect SGPT, ALP and GGT activities. In research, spraying frequency performed by the farmers is 1-2 times per week, which is considered normal.

Appropriate use of PCE

Appropriate or inappropriate use of PCE does not affect SGPT, ALP and GGT activities. However, PCE becomes urgent in order to lessen growers' contact with pesticides. Farmers in present research use PCE regardless of its lack of procedure or standard. They use maskers during the spraying, notwithstanding its condition, which is able to reduce poison absorption especially through inhalation. A research by Siwiendrayanti et al (2012), argues that PCE use does not affect liver function problem.

The amount of pesticides correlates with SGPT activity due to SGPT's nature as transaminase enzyme manufactured by the cells of the liver (hepatocyte). SGPT resides in cytoplasm of liver cells (Sherlock, 1995). Hepatocyte cells play role in biotransformation of toxins in the liver. Damage to hepatocyte will make it permeable and allows leakage of SGPT into blood.

Assumptions can be proposed to explain why some parameters of OP pesticides exposure correlate negatively with enzymes activity in the diagnosis of liver function problem. The first assumption, in normal circumstances organs regenerate fast, in which liver cells are included (Fathoni, 2008). Second assumption, interaction of protective food and drink. A study by Sakr (2007), stated that ginger extract may repair damage of the liver. Another research by El-Banna (2009), quoted in Siwiendrayanti et al (2012), shows that garlic extract can repair liver damage due to pesticides Chlorpyrifos. Study also shows that vitamin C extract will lower enzymes activity,

especially those of SGOT, SGPT, ALP and GGT (Ambali, et al., 2011).

CONCLUSION

The following conclusions can be drawn from the present study: Unrecommended dose and pesticides amount can affect cholinesterase serum activity. Amount of pesticides and spraying hours can affect the activity of *Serum Glutamic Pyruvic Transaminase*/SGPT.

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