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OPTIMIZATION TEST OF BRACELET DESIGN AS AN ALTERNATIVE TO EARLY DETECTION OF PROFENOFOS EXPOSURE IN FARMERS

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Abstract

Profenofos is an active substance contained in pesticides of the organophosphate group. Organophosphate group pesticides are one type of pesticide that has many health problems in humans who are exposed. Exposure to profenofos should be detected as early as possible as a form of preventive effort. This study aims to test the optimal bracelet design used as an early detection of profenofos exposure.

The bracelet design test was carried out on 3 variations, including the design of the cube, hose and patient bracelet. The analysis included observations of discoloration in the bracelet and the volume of profenofos that was least sprayed on the bracelet. The results showed that the cube bracelet was the most optimal discoloration compared with two types of bracelets because there was a change in color from red to pink with the least profenofos volume of 20.5 mL.

Keywords: Bracelet, Optimization, Profenofos exposure

1. Introduction

The growth rate of Indonesia's population tends to be high, which is 1.40% in 2010-2014 (Anonim, 2015a). The increase in the population of the population results in an increase in food needs. The more agricultural production increases, the use of pesticides also increases. Organophosphate is an acetylcholinesterase (AChE) inhibitor enzyme used for various management to treat pests around the world (Jan et al., 2015) and is the most widely used type of pesticide by farmers (Raini, 2007). Excess use of insecticides will eventually become waste that pollutes the environment. Profenofos is one of the organophosphate insecticides that enters water bodies through 84% spray and 16% water flow (15% dissolved and 1% adsorbed by particles) (Griffin, 1999).

Organophosphate insecticides act as competitive inhibitors that can inhibit the activity of cholinesterase enzymes accumulated in the central and peripheral nervous system (Srivastava et al., 2010). Acetylcholinesterase (AchE) is sensitive to organophosphate or carbamate pesticides, so plasma activity can be used as a marker against pesticide exposure (Bakhshwan et al., 2009). Based on the results of research that has been carried out to test the level of population health due to exposure to organophosphates and carbamates in the rice, vegetable and onion production center areas, it shows that acetylcholinesterase (AChE) activity is less than 4500 UI in the blood of farmers in Brebes Regency as many as 32.53% farmers, in Cianjur 43.75% and in Indramayu 40%.

Cholinesterase (ChE) activity of less than 4500 UI is an indicator of chronic intoxication. Exposure to this insecticide can also occur in workers in the insecticide industry, as al-Macthab research results in Bangladesh there are 33.7% of workers out of 215 workers exposed to insecticides initiating substandard cholinesterase (ChE) enzyme activity and 12.5% under hazard conditions (Sharma, 2009).

Exposure to profenofos should be detectable in order to obtain preventive efforts as quickly as possible. Early detection through inhibition of the activity of the enzyme acetylcholinesterase (AchE) [9] through blood samples for enzymatic analysis tests using a spectrophotometer [10], or biosensor [11] with urine sample [12] [13]. The use of these three tools requires expensive material costs, long processes and complicated preparation processes so it is necessary to make other technological breakthroughs to accelerate the detection of profenofos. One of the research prospects for this is to use a silicone bracelet that serves to absorb farmers' sweat, but the process is long enough that researchers try to use Rhodamine 6G solution which is absorbed into the hydrogel.

The use of Rhodamine 6G itself is used because based on research the lower detection ability of Rhodamine 6G dyes can reach 2.2 x 10-2 ug / ml for malathion pesticides and 5.1 x 10-2 for dimethiote pesticides [14]. This ability has the potential to be used as an early detection in exposure to profenofos. This study tried to find the optimal bracelet by varying the type of bracelet against the required profenofos volume as well as looking for a bracelet design that is comfortable to apply in the field. The design of the bracelets evaluated the weaknesses and advantages of each bracelet.

2. Research Methods

There are several stages in this research, including:

a. Stage of preparation of tools and materials

The tools used are a UV-Vis spectrophotometer, cube bracelet, hose, patient bracelet and pesticide spray with a capacity of 16 liters. While the materials used were hydrogel, Rhodamin 6 G (Merck), profenofos (Curacron), distilled water.

b. Contact media creation stage

Contact media was prepared by soaking the hydrogel media with rhodamine 6G at a concentration of 1000 mg/L for 5 minutes, then the hydrogel was inserted into the bracelet. After the bracelet contains the contact medium, it is then sprayed using a profenofos solution with a concentration of 1000 mg/L at a distance of 30 to 40 cm, and repeated 9 times.

c. Stages of making bracelets

There are 3 variations of the bracelet that will be used in this study, including cube bracelets, modified patient bracelets and hose bracelets. The stages of making each bracelet are as follows:

1. Cube Bracelets

The tools and materials needed in making this bracelet include an acrylic box, a strap (floveme brand) and an acrylic cutting machine. The way to make this bracelet is to determine the size of the acrylic box 3cm x 3cm x 1cm with the right and left bases widened by 0.5 cm and given a 0.8 cm long hole in the middle, as a place to hook the bracelet strap. The length of the bracelet rope on each side is 11 cm. One of the sides that has no hook hole, is made a door that can be opened and closed to allow contact media to enter (2.8 x 2.8 cm in size). The upper part/side of the cube box was given 25 holes with a diameter of 0.3 cm and a spacing of 0.2 cm, as a place for profenofos exposure to enter. The design of this bracelet is as follows:

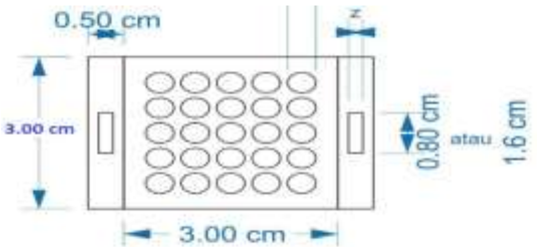

Figure 1. Cross section of a cube ring

2. modified patient bracelets

The patient's bracelet is made of polypropylene which is added with adhesive on the right and left sides. This bracelet has a length of 24 cm and a width of 1 cm which was modified by providing a hook at a distance of 0.5 cm from the left end of the bracelet as a place for the bracelet hole on the right side so that the size of the bracelet can be adjusted to the farmer's wrist. At a distance of 2 to 10.5 cm from the left end, the width of the bracelet which has increased by 2 cm is used as a place to place the hydrogel media by inserting it through the bottom (there is a tear/opening at a distance of 10.5 cm from the left end of the bracelet). If the media when placed is still not strong enough, it can be glued with the help of insulation. A distance of 2.5 to 9.5 cm, the top layer of the bracelet which is clear plastic is torn off with a 1.2 cm wide cutting knife so that when used in the field the selected media can be exposed to profenofos pesticide. At a distance of 10.5 to 24 cm from the left end is a rope with 14 holes with a diameter of 0.4 cm with a distance of 0.6 cm between the holes. The design images of this bracelet are as follows :

Figure 2. Patient bracelets prototype top view

3. hose bracelets

This bracelet is made of a hose made from poly vinyl chloride (PVC) with a diameter of 1 cm and 1.5 cm. The manufacture of this bracelet is by cutting a hose with a diameter of 1.5 cm and a length of 8 cm. The ends of the right and left holes on this hose bracelet are connected to a hose with a diameter of 1 cm and a length of 16 cm to function as a lock. The bracelet is perforated on the surface to provide exposure to 3 holes of profenofos solution. The diameter of the hole on the surface of the hose measures 1 cm and has a distance of 1 cm from the other holes starting from a distance of 1.5 cm to the left of the hose. The hydrogel media that has been soaked with rhodamine 6G is inserted into the 1.5 cm diameter hose ring by removing the 1 cm diameter hose which functions as a lock. The transverse image of the hose bracelet as below:

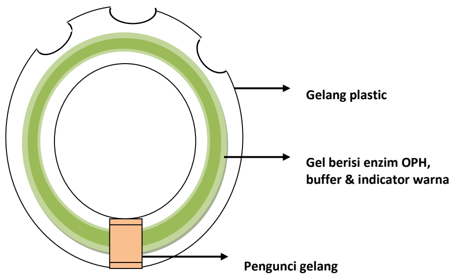

Figure 3. Cross sectional drawing of the hose ring

d. Bracelet trial stage

This stage is the trial phase of spraying profenofos on the contact media inside each bracelet. Spraying the media on the wristbands was carried out with a concentration of 1000 mg/L profenofos solution at a spray distance of 30 to 40 cm and repeated 9 times. At this stage, qualitative and quantitative observations were carried out. Qualitative observations were made to observe changes in the color of the selected media from red to pink. While quantitative observations were carried out by observing and recording the volume of profenofos to change the color of the selected media as an indicator that the profenofos solution had reached the NAV (Threshold Value), namely 300 mg/L.

e. Evaluation Stage

As a result of these variations, a bracelet design with the smallest volume was chosen among the three bracelets. The results of the study evaluated the strengths and weaknesses of each bracelet variation. The results of the best bracelet designs can be applied in the field.

3. Results and Discussion

Field bracelet design testing was carried out to find out the optimal design used for spraying, so the following table displays the results of the bracelet testing.

Table 1. Effect of Bracelet Type on Volume Required to Achieve TLV Profenofos 300 ppm

Types of bracelets	Repeated Spraying Profenofos									
	1	2	3	4	5	6	7	8	9	mean
Hose Bracelet	25	21	22	27	28	21	22	21	22	23,48
Patient Bracelet	25	21	29	27	23	28	25	25	22	25
Cube Bracelet	20	22	18	23	17	22	24	18	18	20

Based on the results of the study in table 1, it shows that the cube bracelet is an effective type of bracelet when used to detect profenofos NAB because it requires less volume compared to the other 2 bracelets, namely the hose bracelet and the patient bracelet. The volume of the cube bracelet needed to reach 300 ppm Profenofos NAB only requires a volume of 20 mL while the patient bracelet and tube bracelet require a volume of 23.48 mL and 25 mL. Based on the results of the study it can be concluded that the most optimal type of bracelet used to detect profenofos NAB is a cube bracelet.

The cube bracelet gets the smallest volume because the cube ring has 25 holes which allow profenofos to interact more quickly with Rhodamine 6 G. The larger surface area will increase the speed of reaction between compounds (Sentot, 2009). The advantage of this cube bracelet is that the profenofos exposure which is accommodated is absorbed by the hydrogel so that no water is spilled when spraying because it is able to bind water and maintain the state of water bound to its structure, but it is not soluble in water [15]. Hydrogels are capable of absorbing water up to 100 times their dry weight. Larger surface area will increase the rate of reaction between compounds (Sentot, 2009). The advantage of this cube bracelet is that the exposure to profenofos that is accommodated is absorbed by the hydrogel so that no water is spilled when spraying is carried out because it is able to bind water and maintain the state of water bound to its structure, but cannot dissolve in water [15]. Hydrogel is able to absorb water up to 100 times its dry weight.

Table 2. Results of Observation of Variations in Bracelet Types After Being Sprayed by Profenofos

Bracelet Types	Observation	Advantages	Weakness
Hose Bracelet 	The color of Rhodamin 6G when sprayed with Profenofos changes from red to pink	1. Simple bracelet design 2. Low cost	1. Hydrogel quickly shrinks 2. Difficult to use, that is, you have to put 2 ends of the bracelet together in the hand

Patient Bracelet 	The color of Rhodamin 6 G when sprayed with Profenofos also changes to pink	1. Simple bracelet design 2. Properties of the bracelet can be used lighter	1. Hydrogel media tends to be always in motion 2. Not enough representative used in the hands 3. The hydrogel cover is not strong easily torn when a hole is made into the entrance of Profenofos
Cube Bracelet 	The color of Rhodamin 6G when sprayed with profenofos changes from red to pink	1. The box is stronger and more stable so that the hydrogel is not easily spilled / loose 2. Hydrogel is more durable not easy to infiltrate	1. The shape of the bracelet is relatively large 2. The nature of the bracelet seems stiff

The results showed that the type of bracelet that effectively detects TLV profenofos is a cube bracelet. This is because the volume required is smaller than other types of bracelets. The cube bracelet obtained the smallest volume because the cube bracelet has 25 holes that allow profenofos to interact more quickly with rhodamine 6G. A larger surface area will increase the reaction speed between its compounds (Sentot, 2009).

The advantage of this cube bracelet is the exposure of profenofos that is accommodated absorbed by the hydrogel so that no water is spilled when spraying is carried out because it is able to bind water and maintain the state of water bound to its structure, but cannot dissolve in water (Selvi, 2010). Hydrogel is able to absorb water up to 100 times its dry weight. Its high absorption capacity causes it to be widely applied in various applications. Application in agriculture as a water bag. Hydrogel is also used as a waste setter in hospitals, baby diapers and also hot compresses (Hardian, 2011).

The bracelet design that has the potential to be applied is a cube bracelet because the bracelet is stronger, with this bracelet the hydrogel is not easily spilled and the hydrogel is not easy to shrink when used as a detection of profenofos exposure. The hose bracelet design feels heavier and less comfortable when worn. Hose bracelets are made of PVC which has hard and rigid properties. The impact strength is good, easily degraded due to heat and light (Ardi, 2013). The patient's bracelet when placed on hydrogel media that tends to always move unstable, making it difficult for not enough representation when used.

4. Conclusion

Based on the research results and discussion, it can be concluded that the average volume of profenofos sprayed on a cube bracelet is at least 20.5 mL. Meanwhile, the average volume of profenofos sprayed on the other 2 types of bracelets was 23.4 mL and 25 mL. The most optimal bracelet design used to detect exposure to profenofos is the cube bracelet design because it is more flexible and comfortable to wear. The research results are expected to be developed as a tool to detect profenofos exposure in farmers.

References

[1] M. Liu, Y. Hashi, Y. Song, J.-M. Lin, 2005, Simultaneous Determination of Carbamate and Organophosphorus Pesticides in Fruits and Vegetables by Liquid Chromatography – Mass Spectrometry, *J. Chromatogr. A*, 1097: 183–187.

[2] G. Palleschi, M. Bernabei, C. Cremisini, M. Mascini, 1992, Determination of Organophosphorus Insecticides with A Choline Electrochemical Biosensor, *Sens. Actuators B: Chem*. 7: 513–517.

[3] E. K. Lee, Y. J. Kim, W. C. Park, T. Chung, Y. T. Lee, 2005, Monoclonal Antibody - Based Enzyme - Linked Immunosorbent Assays for The Detection of The Organophosphorus Insecticide Diazinon, *Anal. Chim. Acta*, 530: 143–153.

[4] W. Zhang, Y. Tang, D. Du, J. Smith, C. Timchalk, D. Liu, *et al*., 2013, Direct Analysis of Trichloropyridinol in Human Saliva Using An Au Nanoparticles-Based Immunochromatographic Test Strip for Biomonitoring of Exposure to Chlorpyrifos, *Talanta*, 114: 261–267.

[5] C. Shi, S. Zhao, K. Zhang, G. Hong, Z. Zhu, 2008, Preparation of Colloidal Gold Immunochromatography Strip for Detection of Methamidophos Residue, *J. Environ. Sci*. 20: 1392–1397.

[6] Z. Li, X. Guo, A.F. Palmer, H. Das, J. Guan, 2018, High-Efficiency Matrix Modulus Induced Cardiac Differentiation of Human Mesenchymal Stem Cells Inside A Thermosensitive Hydrogel, *Acta Biomater*, 8: 3586–3595.

[7] S. M. Reddy, D. M. Hawkins, Q. T. Phan, D. Stevenson, K. Warriner, 2012, Protein Detection Using Hydrogel-Based Molecularly Imprinted Polymers Integrated with Dual Polarisation Interferometry, *Sens. Actuators B: Chem*, 176: 190–197.

[8] K. Deligkaris, T. S. Tadele, W. Olthuis, A. Van Den Berg, 2010, Hydrogel-Based Devices for Biomedical Applications, *Sens. Actuators B: Chem*. 147: 765–774.

[9] Z. Wu, X. Zou, L. Yang, S. Lin, J. Fan, B. Yang, *et al*., 2014, Thermosensitive Hydrogel Used in Dual Drug Delivery System with Paclitaxel-Loaded Micelles for In Situ Treatment of Lung Cancer, *Colloids Surf. B: Biointerfaces*, 122: 90–98.

[10] E. J. Ha, Y. J. Kim, S. S. A. An, Y. R. Kim, J. O. Lee, S. G. Lee, *et al*., 2008, Purification of His-Tagged Proteins Using Ni^{2+} Poly (2 - Acetamidoacrylic Acid) Hydrogel, *J. Chromatogr. B*, 876: 8 - 12.

[11] M. Abdollahi, S. Karami-Mohajeri, 2012, A Comprehensive Review on Experimental and Clinical Findings in Intermediate Syndrome Caused by Organophosphate Poisoning, *Toxicol. Appl. Pharmacol*, 258: 309–314.

[12] S. Chowdhary, R. Bhattacharyya, D. Banerjee, 2014, Acute Organophosphorus Poisoning, *Clin. Chim. Acta*, 431: 66–76.

[13] P. A. D'Agostino, J. R. Hancock, L. R. Provost, 1999, Packed Capillary Liquid Chromatography–Electrospray Mass Spectrometry Analysis of Organophosphorus Chemical Warfare Agents, *J. Chromatogr. A*, 840: 289–294.

[14] B. A. Ingelse, R. C. J. van Dam, R. J. Vreeken, H. G. J. Mol, O. M. Steijger, 2001, Determination of Polar Organophosphorus Pesticides in Aqueous Samples by Direct Injection Using Liquid Chromatography – Tandem Mass Spectrometry, *J. Chromatogr. A*, 918: 67–78.

[15] M. Liu, Y. Hashi, Y. Song, J. M. Lin, 2005, Simultaneous Determination of Carbamate and Organophosphorus Pesticides in Fruits and Vegetables by Liquid Chromatography–Mass Spectrometry, *J. Chromatogr. A*, 1097: 183–187.

[16] G. Palleschi, M. Bernabei, C. Cremisini, M. Mascini, 1992, Determination of Organophosphorus Insecticides with A Choline Electrochemical Biosensor, *Sens. Actuators B: Chem*. 7: 513–517.

[17] E. K. Lee, Y. J. Kim, W. C. Park, T. Chung, Y. T. Lee, 2005, Monoclonal Antibody-Based Enzyme-Linked Immunosorbent Assays for The Detection of The Organophosphorus Insecticide Diazinon, *Anal. Chim. Acta*, 530: 143–153.

[18] W. Zhang, Y. Tang, D. Du, J. Smith, C. Timchalk, D. Liu, *et al*., 2013, Direct Analysis of Trichloropyridinol in Human Saliva Using An Au Nanoparticles-Based Immunochromatographic Test Strip for Biomonitoring of Exposure to Chlorpyrifos, *Talanta*, 114: 261–267.

[19] C. Shi, S. Zhao, K. Zhang, G. Hong, Z. Zhu, 2008, Preparation of Colloidal Gold Immune Chromatography Strip for Detection of Methamidophos Residue, *J. Environ. Sci*, 20: 1392–1397.

[20] Z. Li, X. Guo, A. F. Palmer, H. Das, J. Guan, 2012, High-Efficiency Matrix Modulusinduced Cardiac Differentiation of Human Mesenchymal Stem Cells Inside A Thermosensitive Hydrogel, *Acta Biomater*, 8: 3586–3595.

[21] S. M. Reddy, D. M. Hawkins, Q. T. Phan, D. Stevenson, K. Warriner, 2013, Protein detection using hydrogel-based molecularly imprinted polymers integrated with dual polarisation interferometry, *Sens. Actuators B: Chem*, 176: 190–197.

[22] K. Deligkaris, T. S. Tadele, W. Olthuis, A. Van Den Berg, 2010, Hydrogel-Based Devices for Biomedical Applications, *Sens. Actuators B: Chem*. 147: 765–774.

[23] Z. Wu, X. Zou, L. Yang, S. Lin, J. Fan, B. Yang, *et al*., 2014, Thermosensitive Hydrogen Used in Dual Drug Delivery System with Paclitaxel-Loaded Micelles for In Situ Treatment of Lung Cancer, *Colloids Surf. B: Biointerfaces*, 122: 90–98.

[24] E. J. Ha, Y. J. Kim, S. S. A. An, Y. R. Kim, J. O. Lee, S. G. Lee, *et al*., 2008, Purification of His-Tagged Proteins Using Ni^{2+} Poly (2 - Acetamidoacrylic Acid) Hydrogel, *J. Chromatogr. B*, 876: 8–12.

[25] Suheryanto, D. 2010. *Optimalisasi Celupan Ekstrak Daun Mangga pada Kain Batik Katun dengan Iring Kapur*. Yogyakarta: Balai Besar Kerajinan dan Batik.