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Research article

Survey of pesticides in chicken carcasses and environments of backyard raising system in rural area of Thailand

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Abstract

This study consists of a survey of pesticides in chicken carcasses in the environment of backyard raising systems in rural areas of Thailand, focusing on Mae Taeng District, Chiang Mai Province. It aims to survey organophosphate and carbamate pesticides in soil, water, chicken muscle, and liver samples while assessing the knowledge and behaviors related to pesticide use and backyard chicken rearing. Among 377 farmer households surveyed, 94% displayed high pesticide knowledge, but moderate pesticide usage and irresponsible practices were noted in equipment management and waste disposal. The age of the chicken raiser correlated significantly with pesticide knowledge ($p<0.05$), suggesting older individuals possess greater understanding due to their accumulated experience and education. Environmental samples (soil and water) and chicken samples (muscle and liver) were collected. No organophosphate or carbamate pesticides were detected in the water, chicken muscle, or liver samples. However, soil samples from the Sop Ping Subdistrict tested positive for these pesticides when screened using the GT-Pesticide Test Kit. The High-Performance Liquid Chromatography (HPLC) analysis confirmed that there were non-detectable pesticides in all samples. Further research is required to identify alternative pesticides and examine the quantity in depth to overcome the behavioral barriers to effective pesticide use in chicken rearing. Promoting a positive attitude toward knowledge and practice for achieving sustainable pest management is crucial for farmer well-being and environmental health.

Keywords: Backyard chicken, Carbamate, Organophosphate, Pesticides

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INTRODUCTION

Free-range native chickens play a crucial role in Thai rural livelihoods because they represent high protein sources and contribute to household income. Their ease of maintenance and breed diversity contribute to unique characteristics, such as disease and pest resistance, allowing them to thrive in the rural environment (Heikens et al., 2001). Consumers prefer backyard poultry or native breeding chickens due to their different flavors, good texture, and low fat and cholesterol (Molee, 2012).

Free-range farming is an approach commonly practiced on a small scale, where chickens are given the freedom to engage in natural activities such as dusting, molting, and foraging for plants and insects. This farming practice can pose a risk of pesticide exposure to the backyard chicken production chain if the pesticides are applied in the rearing areas. In rural areas of Thailand, where backyard farming is prevalent, the use of pesticides in chicken-raising systems is not regulated, leading to potential health hazards for consumers and environmental pollution. During the period from 2014 to 2023, Thailand's pesticide imports increased by 10,2018.53 tons on average (Department of Agriculture, 2023). The use of such pesticides creates both direct and indirect problems for animals and the environment. A previous study on the inspection of pesticides in Mae Taeng District, Chiang Mai Province (Saengprakai, 2013), revealed organophosphate and carbamate contamination in soil, water samples, and agricultural products. The actual proportion in soil is 58.2%, especially chlorpyrifos, which has been detected in soil samples, in agricultural areas where backyard chicken raisers have stopped using pesticides for at least three years (Patarasiriwong et al., 2016).

The lack of control and monitoring concerning the use of pesticides in households and agricultural areas nearby is a significant concern. Farmers frequently apply multiple pesticides without adequate training or awareness of the potential hazards (Rattanaprom, 2020). This practice can lead to the accumulation of pesticides in chicken carcasses and their surroundings, posing significant risks to human health and ecosystems. Monitoring pesticides in chicken carcasses and the environment for backyard raising systems is an essential aspect of food safety and environmental monitoring. Therefore, this study aims to survey the pesticides accumulated in chicken carcasses and the environments of backyard raising systems in rural areas of Thailand, while also determining farmers' knowledge and practices regarding pesticide usage.

MATERIALS AND METHODS

This study focuses on the use of pesticides in chicken carcasses and the environments of backyard raising systems in Mae Taeng District, Thailand. The study area was selected because it represents agricultural areas where the use of pesticides is increasing (Chiang Mai Provincial Agriculture and Cooperatives Office, 2023). The study was conducted from July 2022 to June 2023. The research involved surveying the knowledge and practices of chicken raising from the perspective of pesticide usage and examining pesticide residues in both the environment and chicken carcasses.

Survey on the Knowledge and Practice of Chicken Raising and Pesticide Usage

Study site and sampling plan

The sample size was calculated using Krejcie & Morgan's sample size method, the margin of error (e) being within 0.05%, while the percentage of the trait of interest to the population (P) was set to 0.5, resulting in 377 households. The sample was then selected using convenience sampling. The inclusion criteria were

based on households that raise chickens in backyard chicken systems. The questionnaire was modified from the assessment of the Department of Disease Control, Ministry of Health. The modified questionnaire was tested in 30 chicken raisers outside the study area to measure the reliability coefficient alpha. Cronbach's alpha was 0.75. The questionnaire included three components.

Part 1: Demographic information and the factors of backyard chicken raising

Part 2: Acquiring knowledge on the proper use of pesticides. The questionnaire consisted of ten close-ended questions, with "YES" answers scoring 1 point, meaning that the person knows, and "NO" answers scoring 0 points, meaning that the person does not know (Busorn, 2565). The analysis was conducted across three levels: high knowledge (an average total score > 80%), moderate knowledge (an average total score between 60% and 79%), and low knowledge (an average total score < 60%) (Bloom, 1971).

Part 3: The questionnaire on the risk behavior associated with using chemical pesticides in backyard chicken systems comprised 12 questions, using a three-point scale with assigned scores of 1 to 3 points, relating to never, sometimes, and always. The study was analyzed into three levels as follows: high level (always): an average total score between 25 and 36 points; moderate level (sometimes): an average total score between 13 and 24 points; and low level (never): an average total score between 1 and 12 points.

Survey on Pesticide Residue in the Environment and Chicken Carcasses

Study area

Backyard chicken raising is a popular free-range system and allows the birds to scavenge for food naturally (Chiang Mai Livestock Office, 2020). However, pesticide residue in the chicken carcasses is a cause for concern. The questionnaire survey was divided into chemical and non-chemical use areas at the subdistrict level.

Sample Size Calculation and Sampling Selection Plan

Environmental and chicken carcass samples were collected using stratified sampling methods to study the residual pesticide content. The G-Power program calculated the sample size for a two-way analysis, assuming a reference standard deviation of 0.3470 (Davitiyananda et al., 1994). A total of 44 samples were collected, evenly split between 22 samples from chemical-use areas and 22 samples from non-chemical. Samples were pooled from representative households. The samples selected from the environment and chicken carcasses consisted of 100 g of chicken muscles and livers from whole chickens. The samples were placed in plastic containers and transported in ice boxes from the polluted and reference sites. The environmental samples (water, soil) collected comprised 1 kilogram of soil taken from five locations (Awsungnoen, 2015) and 1 liter of water from the chicken water supply. Samples were examined using the GT-Pesticide Detection Kit (GT-Test kit) with positive results confirmed by HPLC. The chicken liver and chicken muscle samples were analyzed using an in-house HPLC method, TE-CH-030, Model 1100, from Agilent Technologies, Germany. Soil and water samples were verified using the EN 15662:2008 method with the LC/MSD SL model, also from Agilent Technologies, Germany (Fresenius Z. Chem., 1985, NC.1155).

Statistical Analysis

Data were analyzed by ready-made computer programs using descriptive statistics, including frequency distribution, percentage, mean, deviation standard, and analytical statistics to find the relationship between knowledge and behavior on the use of pesticides in backyard chicken raising. The information on backyard

chicken raisers and other factors was measured by Chi-square Test statistics and the significance was defined at $p \leq 0.05$.

RESULTS

Demographic information and backyard chicken-raising factors

The sample group included backyard chicken raisers aged between 61 and 70 years, representing 37.11% of the total. Their annual income was less than 10,000 baht. In addition, the majority of backyard chicken raisers, accounting for 53%, had 0–10 years of experience in raising backyard chickens. The primary purpose of raising backyard chickens was household consumption, accounting for 49%, with the preferred method of raising being through a free-range system, accounting for 76.6%. The primary source of chicken for backyard systems was the cultivation of poultry breeders in households, accounting for 71.30%. The chicken population per family typically ranged from 21 to 40, accounting for 29.9%. The survey revealed that the majority of backyard chicken enclosures were located in close proximity to residential areas and primarily fed with household food scraps and water, accounting for 77.5%. The primary source of food and water for rearing chickens in backyard systems was from natural resources, accounting for 65.6% (Table 1).

Knowledge of the Use of Pesticides Among Backyard Chicken Raisers

The backyard chicken raisers with a high level of knowledge of pesticide use accounted for 94%, while those with a moderate level of knowledge accounted for 6% (Table 3). When analyzing the levels of chemical knowledge, 99.7% of chicken raisers correctly responded that pesticides impacted the neurological system, and they read the labels before buying and using pesticides. Additionally, 98.9% of chicken raisers reported being knowledgeable about chemical usage, including reading labels before use. Before buying and applying pesticides, 98.9% read the labels, and the chicken raisers knew that spraying pesticides without safeguards exposed the body to 95.5% more chemicals. When asked about landfill destruction or hazardous waste separation, 17.8% of backyard chicken raisers incorrectly responded, as did 8.2% when asked about using a clogged mouthpiece spray nozzle (Table 2). When a relationship between personal information and the level of knowledge on the use of chemical pesticides was found, the proper use of pesticides was significant, particularly among individuals aged 51–70 years ($p<0.05$).

Table 1 Demographic information of the chicken raisers

Information	Counts (n=377)	%
Age (years)		
31–40	31	8.2
41-50	40	10.7
51-60	111	29.4
61-70	140	37.1
More than 71	55	14.6
Annual income (baht per year)		
Less 10,000	109	28.9
10,001-30,000	216	57.2
30,001-50,000	37	9.8
More than 50,000	15	4.1
Experience of raising backyard chickens (years)		
0-10	200	53.0
11-20	90	23.8
21-30	59	15.8
More than 30	28	7.43
Purpose of raising backyard chickens		
Household consumption	185	49.0
Raising and selling live chickens	160	42.8
Raised to be slaughtered and sold	13	3.6
Others, such as fighting cocks, are fancy chicken, etc.	11	2.3
Household consumption and selling live domestic chickens	8	2.3
Number of Chicken		
1-20	107	28.4
21-40	112	29.9
41-60	92	24.4
61-80	15	4.1
More than 80	51	13.7
Source of chickens in backyard chicken systems		
Poultry breeder cultivation in household	267	71.3
Buy from sources inside the district	66	17.6
Distribution	31	8.2
Buy from sources outside the district	13	3.8
Types of chicken raising		
Free-range system	290	76.6
Battery cage raising	44	12.0
Semi-free-range system	32	8.4
Type of near backyard chicken raising area		
Residential areas	271	71.9
Agricultural areas	100	26.5
Animal husbandry areas	5	1.3
Forested regions	1	0.3
Types of Chicken Feed		
Food scraps	292	77.5
Pellet chicken feed	52	13.7
Mash Chicken Feed mix Pellet Chicken Feed	19	5.2
Organic feed	14	3.6
Types of chicken raising		
Free-range system	290	76.6
Battery cage raising	44	12.0
Semi-free-range system	32	8.4

Table 2 Percentage of chicken raisers with correct responses on chemical usage (N=377)

No.	Question	Answer (%)	
		Correct	Wrong
1	Read the labels on pesticides before buying and using them.	98.9	1.1
2	Need to wear protective gear when spraying pesticides to avoid exposing body to more chemicals and pesticides.	95.5	4.5
3	Containers with pesticides be disposed of properly, like through landfill, destruction, or separating them as hazardous waste.	82.2	17.8
4	Wash your hands or take a shower right after touching or spraying pesticides to prevent them from getting into body.	96.0	4.0
5	Do not use your mouth to unclog the spray nozzle if it gets blocked.	91.8	8.2
6	Do not enter the sprayed area right after applying the chemicals.	94.2	5.8
7	If the chemical tanks leak while spraying, it can lead to the body getting more chemicals.	95.2	4.8
8	If you find someone allergic to pesticides, give them first aid immediately and suggest using a different type of pesticide.	92.6	7.4
9	It is unsafe to mix pesticides in a closed area.	93.9	6.1
10	Pesticides can impact the nervous system and muscles	99.7	0.3

Table 3 Knowledge level of chicken raisers on chemical usage

Knowledge level	Counts	%
High knowledge (total score>80%)	354	94
Moderate knowledge (total score 60 -79%)	22	6
Low knowledge (total score < 60%)	0	0

Risk Behavior Associated with the Use of Chemicals and Pesticides in Backyard Chicken Systems

The study found that risk behavior was associated with the use of chemicals and pesticides in backyard chicken systems at a moderate level of 85.9% (Table 5). The majority of backyard chicken raisers (99.7%) did not answer, while 98.7% threw any remaining pesticide on the floor immediately after use without digging a hole and covering it with lime. However, 13.3% of chicken raisers answered with inactive behavior. During spraying, some backyard chicken raisers took breaks to eat or smoke without changing their clothes or showering, accounting for 11.9%. In response to question 12 about storing pesticide containers and equipment near food storage areas, 11.4% of chicken raisers were found to lack knowledge of proper pesticide disposal and use (Table 4). Table 5 shows a significant relationship ($p < 0.05$) between experience in raising backyard chickens and risky behaviors related to chemical use in backyard chicken systems. When comparing the relationships between each question, a significant relationship ($p<0.05$) was found with question 6, which referred to the washing of spraying equipment and the removal of chemicals by washing and putting water on the floor and washing containers in natural local water sources such as community canals, streams, rivers, etc., and experience of raising backyard chickens.

Table 4 Risk-associated behaviors in the use of chemicals and pesticides in backyard chicken systems (N=377)

No.	Question	Answer (%)		
		Always	Sometime	Never
1	How often do you recycle used chemical containers appropriately.	0.3	0	99.7
2	Mix pesticides according to the farmers' own recommendations or according to belief without looking at the ratio as recommended by the label	2.4	0	97.6
3	Use your bare hands to stir or not wearing gloves while measuring or pouring substances	2.1	0	97.9
4	Do not wear protective shirts, mask, gloves and goggles.	4.8	0	95.2
5	Pour wastewater for cleaning clothes or equipment on the ground near chicken raising areas	1.3	0	98.7
6	Wash containers in natural household water sources such as community canals, streams, rivers, etc.	1.1	85.1	13.8
7	Pour out any remaining and unused pesticides on the ground in the chicken's feeding territory or pour it in the same water source used to raise chickens.	2.1	0	97.9
8	Throw away any remaining pesticides on the floor.	1.3	0	98.7
9	During spraying, you can take a break to eat or smoke normally without changing clothes or showering.	13.3	0	86.7
10	Place and store containers and equipment near the chicken raising area.	11.7	0	88.3
11	Place and store containers and equipment in the same place as storing food for raising chickens.	11.9	0	88.1
12	Use the same containers and equipment for pesticide and raising chickens.	11.4	1.9	86.7

Table 5 Behavior level of chicken raisers in chemical usage

Behavior level	Counts	(%)
High risk (total score =25-36 points)	0	0.0
Moderate risk (total score =13-24 points)	324	85.9
Low risk (total score =1-22 points)	53	14.1

Survey on Pesticide Residue in the Environment and Chicken Carcasses

The survey analysis on the use of chemical pesticides in conjunction with backyard chicken farming methods reveals that, in the Mae Taeng District of Chiang Mai Province, there are four non-chemical areas, while seven subdistricts use chemical pesticides (Figure 1) falling into the categories of insecticides, herbicides, medications, and supplements. In the Sop Ping Subdistrict, the highest number of households using chemicals is ten, with most using insecticides. In contrast, Mae Hor Phra Subdistrict has the least number of households using chemicals, at only three, and backyard chicken raisers do not have clear records of chemical use. In the GT-Test kit method screening analysis, none of the samples from non-chemical locations yielded positive results for soil, water, chicken muscle, or chicken liver. However, the use of chemicals in the chemical area yielded positive results for soil samples from the Sop Ping Subdistrict. These samples were put through the confirmation process using the HPLC method. It was determined that the chicken carcasses, soil samples, and water samples did not contain any detectable levels of the carbamate group at the limit of detection (LOD) of 0.01 mg/kg and 0.01 mg/L, respectively. Similarly, at the LOD of 0.01 mg/kg, the chicken carcass samples showed no detectable levels of the organophosphate group. The concentrations of EPN, Prosalone, and Azinpho-ethyl in chicken carcass samples and soil were found to be below the LOD of 0.02 mg/kg. Similarly, in water samples, the concentrations of these substances were below the LOD of 0.02 mg/L. The concentrations of all other substances were below the LOD of 0.01 mg/kg in chicken carcass samples and soil, while below the LOD of 0.01 mg/L in water samples.

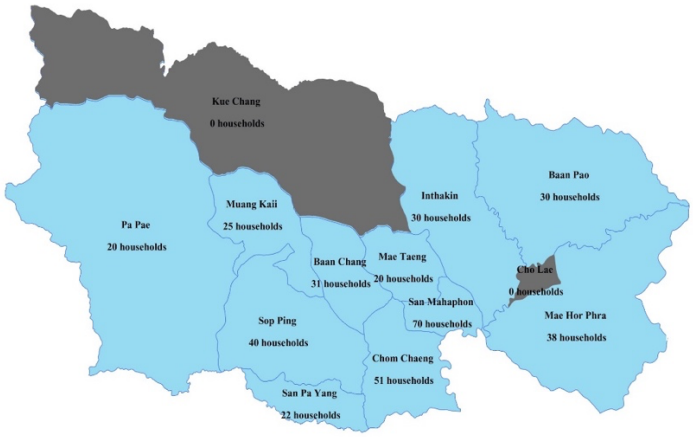

Figure 1 Geographical map and number of household samples

DISCUSSION

The quantitative analysis of pesticides in chicken carcasses and the environments of backyard raising systems in rural areas of Thailand revealed that the sample of backyard chicken raisers had a high level of knowledge on the use of pesticides. Most chicken raisers were between 51 and 60 years old, with 0 to 10 years of experience in raising chickens. Through their personal experiences and generational transmission, they acquired the skill of safely handling chemicals, and they also explored the potential of using indigenous pesticidal plants for insect pest control with small-scale farmers in Africa. Previous research reveals that Africans, through their personal experiences and inherited folk wisdom, have become aware of the risks associated with chemical pesticide use when raising small animals (Mkindi, 2015; Nunthasen, 2017). A study in Sisaket Province on farmers' knowledge, attitudes, and behaviors regarding chemical insecticide use found that those with 10–20 years of agricultural experience generally understood pesticide safety (Thammasri, 2021). However, 13.3% of farmers reported practices such as eating or smoking during spraying without changing their clothes or showering and storing pesticide containers alongside food for chickens. These habits may stem from inadequate consideration of the environmental impacts, exacerbated by low professional skills and a reluctance to adopt modern technology among elderly farmers (Duangbutsri, 2020). Additionally, rushing to complete tasks can lead to them neglecting safe pesticide use practices (Kitima, 2014).

In terms of the organophosphate and carbamate pesticides in the environmental samples (soil and water), as well as chicken carcasses (chicken muscle and chicken liver), the GT-Test kit yielded a positive outcome when analyzing a soil sample from a chicken farming region in Sop Ping Subdistrict. This result provided confirmation of the test by HPLC, and that outcome was determined to be negative within the LOD. The examination of chicken carcass samples, specifically muscle and liver, indicated the absence of contamination in both the carbamate and organophosphate categories. Chlorpyrifos, a discontinued substance previously used in Thai agriculture, was not found in the sample when detected by the HPLC method. No contamination was found at a level of 0.01 or below, and the amount detected fell within the safe range specified by the Thai Agricultural Commodity and Food Standard (TACFS 6700, 2005) for chicken meat. This standard sets a maximum residue limit of 0.01 for chlorpyrifos derivatives in this category (Ministry of Agriculture and Cooperatives, 2009).

However, no chemical contamination was detected in water samples from both areas under study, nor in the muscles and liver of chickens. In addition, organophosphate pesticide residues in environmental and biological matrices are relatively less persistent in the environment than their organochlorine counterparts (Ore, 2023). Moreover, different types of soil and sediment have varying levels of chemical binding capacity. The half-life of some organophosphates is between 6.4 to 2,256 hours in Dicapthon and Dursban (Mdeni et al., 2022). However, a review of pesticide and other chemical use in the sample area revealed the use of pyrethroids, a group of insecticides used to eliminate insects in backyard chicken raising. Pyrethroid-containing insecticides can potentially lead to positive results in the GT-Test kit screening, which relies on the principle of cholinesterase inhibition. The principle of the cholinesterase inhibition technique involves measuring the toxicity of all types of pesticide residues in the sample analyzed. It can cover pesticides such as organophosphate, carbamate, and other toxic substances that are cholinesterase inhibitors. When examined and analyzed for confirmation, it was found that the samples showed no contamination of organophosphates and carbamates. Therefore, the soil sample showed a positive result for contamination with pyrethroid toxins, which are classified as cholinesterase inhibitors (Beasley, 2013; Ahamad, 2023). When considered together with the use of chemicals by chicken farmers, pyrethroid chemicals were found to be used in the chemical use area. In this study, there are still limitations in the information on chicken farmers' use of pesticides, such as trade names, chemical names, and frequency of use. This is because chicken farmers tend to be elderly, between 61 and 70 years old (Table 1), and the purpose of raising chickens is for household consumption. Incomplete information exists regarding the use of medicines and pesticides in backyard raising systems. Most of the areas surrounding backyard raising systems are residential and agricultural, with the backyard chicken raisers being unable to identify the chemicals used in nearby agricultural areas.

CONCLUSIONS

The study found no contamination of carbamates and organophosphates in the soil, water, and chicken carcasses in Mae Taeng District, Chiang Mai Province. The knowledge level on the proper use of pesticides was not significantly correlated with the level of risk-related behavior. The agencies and government bodies are advised to use its findings to examine backyard chicken safety and educate poultry farmers on the use of chemicals.

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AUTHOR CONTRIBUTIONS

Natnaree Rakarkaraphokhin : Conceptualization, Methodology, Investigation, Analysis and interpretation, Writing
Montira Intanon : Conceptualization, Methodology, Supervision
Nattakarn Awaiwanont : Conceptualization, Methodology, Supervision
Warangkhana Chaisowwong : Conceptualization, Methodology, Supervision, Critical review and editing

REFERENCES

Ahamad, A., Kumar, J., 2023. Pyrethroid pesticides: An overview on classification, toxicological assessment and monitoring. J. Hazard. Mater. 10, 100284.

Bloom, B.S., Madaus, G.F., Hastings, J.T., 1971. Handbook on formative and summative evaluation of student learning. McGraw-Hill, New York.

Busorn, T., 2022. Knowledge and behavior of pesticide use of farmers. In the area responsible for DenLek Health Promoting Hospital, Nampad District, Uttaradit Province. Regional Health Promotion Center 2 Phitsanulok, Phitsanulok, pp. 8-9.

Danis, D., Wara, P., 1994. Determination on residue in chicken meat and liver from local market and supermarket. J. Health Res. 8(1), 21-30.

Department of Agriculture, 2023. Amount of imported agricultural hazardous. Available online: https://doa.gdcatalog.go.th/group/information.

Patarasiriwong, V., et al., 2016. A study on the development of chemical reduction guidelines in agriculture with a participatory research process: case study, Mae Taeng District, Chiang Mai Province. Environmental Research and Training Center, Vanvimol Patarasiriwong, Bangkok, pp. 80–101.

Heikens, A., Peijnenburg, W.J.G.M., Hendriks, A.J., 2001. Bioaccumulation of heavy metals in terrestrial invertebrates. Environ. Pollut. 113(3), 385-393.

Kitima, S., 2014. Pesticide use behaviors among longan-farmers in Ban Sopmoei, Mae Tha District, Lamphun Province. Chiang Mai University Faculty of Public Health, Chiang Mai, pp. 28-45

Mkindi, A., Mtei, K., Njau, K., Ndakidemi, P., 2015. The potential of using indigenous pesticidal plants for insect pest control to small scale farmers in Africa. Am. J. Plant Sci. 6, 3164-3174.

Molee, D.W., 2012. Effect of free range native chicken farming on growth performance, cholesterol content and fatty acid composition of meat. Suranaree University of Technology, Nakhon Ratchasima, pp. 12-28.

Nunthasen, W., Nunthasen, K., 2017. Farmer's knowledge of chemical use. HUMSU. 36, 44-52. [In Thai]

Ore, O.T., Adeola, A.O., Bayode, A.A., Adedipe, D.T., Nomngongo, P.N., 2023. Organophosphate pesticide residues in environmental and biological matrices: Occurrence, distribution and potential remedial approaches. Environ. Chem. Ecotoxicol. 5, 9-23.

Rattanaprom, W., Sanwong, S., Nuttapong, P., 2020. Risk assessment of farmers using pesticides in Nongplasawai Sub-District, Banthong District, Lamphun Province. Academic J. Community Public Health. 6, 143-154. [In Thai]

Saengprakai, C., 2013. Contamination of nitrite in food and toxicity risk [In Thai]. Kasetsart Ext J. 58(2), 10-15. [In Thai]

Suthasinee, A., 2015. Environmental impact from pesticide utilization. EAU Heritage J. Sci. Technol. 9, 50-63. [In Thai]

Thammasri, W., Phomauthai, S., Budsayatrus, W., Salangam, S., 2021. Knowledge, attitude and chemical insecticide use behavior of corn farmers in Sriratana district, Sisaket province. SWUJ. 7, 71-81. [In Thai]

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