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IMPACT OF LEAD RISK (Pb) DUE TO CABBAGE CONSUMPTION ON THE COMMUNITY OF SUBAN AYAM VILLAGE, REJANG LEBONG DISTRICT 2022

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ABSTRACT

The use of pesticides in the process of growing vegetables can cause the presence of heavy metals such as lead that can have an impact on people's health. This study aims to analyze carcinogenic health risks as one of the impacts of lead contamination on cabbage. This research was conducted using quantitative methods and environmental health risk analysis (ARKL). The sample used the Purposive Sampling method which consisted of 96 community respondents and 10 cabbage samples taken using the Random Sampling method and will be analyzed at the Palembang Health Laboratory Center. The results of the analysis of lead content in cabbage showed an average of 0.0458 mg/kg. The Result also found that respondents from Suban Ayam Village had an average ECR lifetime of 0.000229 or an ECR value > 10-4. This shows that the consumption of lead-contaminated cabbage in Suban Ayam Village have risk of carcinogenic disease. Risk forecasts for the next 30 years show that the average ECR value is 4.128E-04 or ECR > 10-4. Based on the results of the analysis showing that the carcinogenic risk characteristics of lead exceed the threshold, risk management is needed by reducing the use of chemical pesticides containing active ingredients and heavy metals to reduce the residual lead levels of pesticides in cabbage to a predetermined safe limit. In addition, risk management can be carried out by reducing the intake rate of cabbage by reducing consumption of cabbage and being able to vary it with other types of vegetables while maintaining the cleanliness of vegetables before consumption.

Keywords: Environmental Health Risk Analysis; Cabbage; Lead

Introduction

Food contamination is a condition where foreign substances enter food so that the food is contaminated[1]. Food safety problems are something that almost all countries in the world suffer from. Foodborne disease or food-borne illness is one of the most common diseases in the world, according to WHO, food-borne illness dominates around 70% of the 1.5 billion health problems[2].

The presence of heavy metal contamination entering food is one of the factors causing food contamination. Heavy metal pollution can enter the human body through oral, inhalation and dermal exposure. One type of heavy metal that can contaminate food is lead (Pb). One of the causes of lead contamination in food can occur in vegetables that are contaminated with residue due to pesticide spraying[3].

Agricultural products such as cabbage production must be of good quality and safe for consumption by the public. Many vegetables marketed by distributors are classified as unsafe, this is due to suspected heavy metal contamination, for example lead (Pb)[4]. If these vegetables are not

washed thoroughly and thoroughly, they may still contain harmful substances such as lead that stick to the surface of the vegetables and harm humans and if they accumulate in the body[5].

Lead is classified as a group B2 heavy metal or a compound that can pose a carcinogenic risk. The International Agency for Research on Cancer (IARC) states that inorganic lead compounds or Group 2A can pose a carcinogenic health risk or cancer in humans, this was obtained through fairly limited data on the risk of cancer in humans and there is sufficient evidence in animals[6]. Based on this data and information, the author was encouraged to conduct research entitled Impact of Lead (Pb) Risk Due to Consumption of Cabbage in the Community of Suban Ayam Village, Rejang Lebong Regency in 2022.

Methods

This research is a quantitative research with an environmental health risk analysis (ARKL) approach consisting of hazard identification, exposure analysis, dose response analysis, risk characterization and risk management. The samples used included a sample of respondents and a sample of cabbage. The sample of respondents was determined using a purposive sampling method with a Non Probability Sampling technique, so that a total of 96 respondents were obtained. Cabbage samples were taken using the Random Sampling method which referred to SNI 19-0428-1998 concerning instructions for taking solid samples. Where the sample taken is 10 samples representing 96 respondents. This research used direct observation, filling out questionnaires, and interviewing respondents to collect data and carried out laboratory tests on cabbage samples that were indicated to be exposed to lead contamination. The questionnaire contained questions to obtain data on body weight, rate of intake, frequency of exposure, duration of exposure in consuming cabbage from agricultural products in Suban Ayam Village.

Results

Lead Concentration in Cabbage in Suban Ayam Village

The results of the analysis of Lead (Pb) concentrations in cabbage can be seen in table 1 below:

Table 1 Results of Statistical Analysis of Lead Content in Cabbage

Variable	Mean	Median	SD	Min	Max
Lead Concentration (Pb)	0,0458	0,032	0,0314	0,005	0,103

The results of laboratory tests for lead (Pb) levels on 10 samples of cabbage from Suban Ayam Village showed that the average value of lead content was 0.0458 mg/kg, where this result is still below the threshold value for lead in food according to SNI 7387 of 2009 concerning The limit of Lead (Pb)

Heavy Metal Contamination in Vegetables is 0.25 mg/kg.

Anthropometric Characteristics of the Suban Ayam Village Community

The results of the analysis of the anthropometric characteristics of the people in Suban Ayam Village consisting of body weight and intake rate can be seen in table 2 below:

Table 2. Results of Statistical Analysis of Community Anthropometric Characteristics

Variable	Mean	Median	SD	Min	Max
Weight	59,78	60	10,084	35	87
Intake Rate	100,26	100	58,770	50	250

The results of the statistical analysis showed that the average body weight of the respondents in Suban Ayam Village was 59.78 kg. With the lowest respondent's body weight of 35 kg and the respondent with the highest body weight of 87 kg, with an average intake rate of respondents in Suban Ayam Village of 100.26 gr/day.

Community Activity Patterns in Suban Ayam Village

The results of the analysis of community activity patterns in Suban Ayam Village which consist of the frequency of exposure and the duration of exposure can be seen in table 3 below:

Table 3.Results of Statistical Analysis of Community Activity Patterns

Variable	Mean	Median	SD	Min	Max
Exposure Frequency	98,58	104	49,175	52	260
Duration of Exposure	19,04	11	16,583	2	63

In the exposure frequency variable, the results showed that in one year the average consumption of cabbage was 98 days/year. With a maximum value of 260 days/year and a minimum value of 52 days/year. The duration of exposure of respondents to consuming cabbage was an average of 19 years.

Environmental Health Risk Analysis

Community Carcinogenic Intake in Suban Ayam Village

Intake is calculated based on the variables of exposure concentration, body weight, rate of intake, frequency of exposure, duration of exposure, and an average time period of 25,550. The calculation results can be seen in the following table:

Table 4. Calculation Results of Carcinogenic Intake Variable Average

Variable	Average
Carcinogenik Intake	0,005454 mg/kg/day

Based on the results of calculations using the intake formula, the amount of carcinogenic lead intake in calculating lifetime time has an average value of 0.005454 mg/kg/day.

Characteristics of Community Carcinogenic Risk in Suban Ayam Village

Risk characteristics are the result of determining whether or not the consumption of cabbage contaminated with lead (Pb) is safe or not. Risk calculations are carried out by comparing intake with the slope factor (SF) value for carcinogenic risk.

Table 5. Carcinogenic Risk Characteristics

Variabel	Average
Carcinogenic Risk Characteristics	0,000229 mg/kg/day

Based on the calculation results above, it is known that the ECR value for lifetime exposure has an average of 2.29E-04 mg/kg/day

Estimation of Carcinogenic Health Risk among Respondents in Suban Ayam Village

The results of the estimated risk of lead content in cabbage in Suban Ayam Village over the next 10 years, 20 years and 30 years are as follows:

Table 6. Estimated Carcinogenic Risk of Consuming Cabbage

	10 Years	20 Years	30 Years
Mean ECR	1,376E-04	2,752E-04	4,128E-04

There is an increase in the ECR value from 10 years to 20 years to 30 years. The latest calculation for 30 years shows that the average ECR value is 4.128E-04 or ECR > 10-4, which means that consumption of cabbage containing lead has a carcinogenic health risk.

Carcinogenic Risk Management of Lead Content in Cabbage in Suban Ayam Village

Risk management is carried out if the ECR value exceeds the threshold. The risk management that can be carried out is by determining the safe concentration value and safe intake rate as shown in the following table:

Table 7. Lead Carcinogenic Risk Management

Risk Management	Concentration Average	Safe Carcinogenic Concentration (mg/kg)		
		Mean	Max	Min
Safe Concentration of Lead	0,0458 mg/kg	0,0212	0,0327	0,0017
Safe Intake Rate of Lead	100,26 mg/day	47,26	357,60	7,66

Based on the results of risk management calculations, the safe concentration of carcinogenic lead has an average value of 0.0327 mg/kg, with a minimum value of 0.0017 mg/kg and a maximum value of 0.0327 mg/kg. while for the safe intake rate it was found that the safe concentration of the carcinogenic intake rate of cabbage in Suban Ayam Village had an average of 47.26 g/day, with the lowest intake rate of 7.66 gr/day and the highest intake rate of 357.60 mg /day.

Discussion

Based on tests conducted by the Palembang Health Laboratory Center using the Atomic Absorption Spectrophotometry (AAS) method on the concentration of lead which contaminates cabbage from the agricultural produce of Suban Ayam Village, it was found that the 10 samples analyzed had an average concentration of 0.0458 mg/kg , where the results are still below the lead concentration threshold,

namely 0.25 mg/kg. These results are in line with Anindityo[8]'s research. The lead content in plants is due to the presence of active ingredients in pesticides such as Mankozep, Karbofuren, Propinep, Triozopos, Oxifluorfen, and so on.

Spraying pesticides that are carried out can leave heavy metal residues and other active ingredients on vegetables and soil exposed to pesticides[9]. The cause of heavy metal lead contamination in the agricultural sector in Suban Ayam Village is the use of chemical pesticides. Spraying pesticides on cabbage is useful for preventing nuisance organisms such as leaf caterpillars (Plutella xylostella) which are often found in leafy vegetables such as cabbage[8].

Generally, farmers have the mindset that the emergence of pests and diseases is the main cause of crop failure. Therefore, they consider that chemical pesticides can be a solution to overcome pests and diseases in plants. The use of pesticides is carried out from the beginning to the end of the planting period, namely tillage, preparation of planting land, plant maintenance, harvesting, and post-harvest[10].

Based on the results of measurements of respondents, the average respondent in Suban Ayam Village had a body weight of 59.78 kg. Data on the respondent's weight is one of the variables that influence intake calculations, where body weight is used to calculate the intake of each respondent in consuming lead-contaminated cabbage[11]. A person's body weight affects the levels of heavy metals that enter the body. Someone who has a lower body weight tends to have a higher risk of experiencing lead toxicity than someone who has a higher body weight. In other words, the higher the respondent's weight, the lower the risk of suffering from carcinogenic and non-carcinogenic diseases[12].

Based on interview results, the average respondent in Suban Ayam Village consumes 100.26 grams of cabbage/day. The rate of intake of cabbage in Suban Ayam Village is high, because cabbage is the largest agricultural product in Selupu Rejang District, especially in Suban Ayam

Village[7]. Apart from the fact that cabbage is a type of vegetable which is the highest agricultural product in Suban Ayam Village, people tend to consume their own agricultural products and these vegetables are mostly sold along village roads making it easier for people to consume cabbage.

The results of this study are in line with Nurlete's study (2014) which stated that the rate of respondents' intake of mackerel and blood clams had a fairly high average value because the more mackerel and blood clams consumed (gr/day), the greater the the rate of intake obtained. So the greater the risk of respondents being exposed to lead which contaminates mackerel and blood cockles[13].

Frequency of exposure can be defined as how long a person is exposed to a risk agent. In other words, exposure frequency is the number of days in one year a person consumes cabbage that is contaminated with lead. Based on the research, the results showed that the average respondent in Suban Ayam Village consumed cabbage 98 days a year. This research is in line with Alwi's research (2013)[14] that students who consumed green mussels with a higher frequency had higher levels of lead in their urine as well. So it can be concluded that the frequency of exposure affects the concentration of lead in the body.

The duration of exposure is the length of time the respondent is exposed to a risk agent, in this case the duration of lifetime exposure is calculated from the time the respondent starts consuming cabbage from agriculture in Suban Ayam Village. Based on the results of the study, the average duration of exposure was 19 years, the longest exposure duration was 63 years and the shortest was 2 years. The duration of exposure affects the value of intake, where the longer the duration of exposure, the higher the health risks that will be experienced by respondents[15].

Calculation of intake values was carried out using data on body weight, rate of intake, frequency of exposure, duration of exposure for each respondent, and the average concentration of lead detected in cabbage. Based on the results of calculations and research carried out, the estimated carcinogenic intake value for the next 70 years or lifetime exposure is 0.005454 mg/kg/day.

The high intake calculation is influenced by the intake rate value, where the lowest intake rate is cabbage. Maddusa's research (2022)[13] is in line with this research where the greater the rate of food intake, the greater the intake value and the level of risk for experiencing health problems. Intake or the amount of risk agent intake that enters the body is a value that is directly proportional to the lead concentration, rate of intake, duration of exposure, and frequency of exposure. This influences the intake value where the greater the value of this variable, the greater the value of intake[14].

This research is in line with research by Maria (2017) which states that the greater the rate of food intake, the greater the intake value and the level of risk for experiencing health problems. Intake or the amount of risk agent intake that enters the body is a value that is directly proportional

to lead concentration, rate of intake, duration of exposure, and frequency of exposure[22]

In calculating the carcinogenic risk characteristics, the results showed that the ECR lifetime had an average of 2.29E-04. Apart from that, based on ECR calculations per individual, 58 respondents recorded an ECR value of $>10^{-4}$, meaning that these respondents had a risk of developing carcinogenic symptoms or diseases due to consumption of cabbage from the long period of consumption of cabbage until the time of the study or within the lifetime period. Based on the results of this research, there were several respondents who consumed cabbage in real time periods who had RQ values that did not exceed the threshold. However, when calculations were carried out by estimating projections of up to 70 years or lifetime, the result was that the respondent had an ECR value that exceeded the threshold, which means that the respondent had the potential to be exposed to carcinogenic diseases in the next 70 years.

This research is in line with the results of research by Rida (2021) that the length of time a person is exposed to sources of pollution can be a factor in the possibility of lead accumulation, so risk management is needed to reduce the impact of lead poisoning, both carcinogenic and non-carcinogenic risks in the next few years[23].

This research is supported by the results of research by Hapsari (2017) where the results show that the length of time a person is exposed to sources of pollution can be a factor in the possibility of lead accumulation[20]. Exposure to lead over a relatively long period of time can cause damage to various organ systems[15]. The first impact of chronic pollution before it hits the organs of the body is the inhibition of hemoglobin biosynthesis, if this incident is not treated immediately it will continue to affect other organs of the body[16]. This lead poisoning causes obesity levels in the aorta, liver, kidneys, pancreas, lungs, bones, spleen, testes, heart and brain[17].

Estimation of health risks due to consumption of lead-containing cabbage is useful for predicting risks that will occur in the next few years. Based on the calculation results show that the value of ECR in the next few years will increase in the time period of 10 years, 20 years, up to 30 years. This is due to the increasing duration of exposure and adjusting to the consumption of cabbage which is indicated to be contaminated with lead. The calculation results for the longest duration of exposure, namely 30 years, for carcinogenic risk or ECR in the next 30 years has an average of 4.128E-04 or $ECR>10^{-4}$

This result is in line with research by Ma'rufi (2014)[18] where consumption of a food indicated by lead is projected in the future so that ECR results that exceed the threshold are obtained. Based on these results, efforts are needed to reduce existing health risks by reducing the use of pesticides that contain heavy metals to reduce lead contamination originating from these pesticide residues.

If the value of the risk characteristics exceeds the threshold, risk management is formulated. Determination of the safe limit for toxic agents through the ingestion exposure route can be done

by determining the safe limit of exposure concentration (C) and intake rate (R). Because lead contamination in cabbage is caused by residues from pesticides, the risk management is to reduce lead concentrations in cabbage, namely by means of local farmers through agricultural extension workers to reduce the use of chemical pesticides and try to use pesticides with organic ingredients[17].

The rate of intake of cabbage consumption also affects the level of risk of disease due to lead exposure. After doing the calculations, it is necessary to reduce the consumption of cabbage. Society can vary the types of vegetables consumed. The determination of the safe intake rate for each respondent differs depending on the respondent's body weight and frequency of consuming cabbage. In addition, people are also advised to wash and cook cabbage before consuming it[24].

It is advisable for farmers to schedule pesticide spraying times before harvest so that the residue levels remaining on vegetables before harvest are low, besides that there is a need for research on the effect of mixing types of pesticides with the amount of residue left on vegetables[25]

Conclusion

The concentration of lead in cabbage in Suban Ayam Village is indicated to be still below the threshold, namely 0.0458 mg/kg/day. Meanwhile, in the ECR calculation, it exceeds the threshold with an average of 2.29E-04, so the consumption of cabbage vegetables is contaminated with lead in Suban Ayam Village. may pose a carcinogenic risk. The risk estimate of the ECR value has increased in 10 years. 20 years, and 30 years to come. The carcinogenic risk characteristics of lead that exceed the threshold require risk management by reducing the use of chemical pesticides containing active ingredients and heavy metals to reduce lead levels of residual pesticide residues in cabbage to a predetermined safe limit. Apart from that, risk management can be done by reducing the rate of cabbage intake by reducing cabbage consumption and by varying it with other types of vegetables and maintaining the cleanliness of vegetables before consumption.

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Conflict of Interest

The authors declare that they have no conflict of interest.

Reference

1. Depkes. Kontaminasi Makanan (Food Contamination) oleh Jamur, Forum Ilmiah Kesehatan (FORIKES). 2016
2. Lestari TRP. Keamanan Pangan Sebagai Salah Satu Upaya Perlindungan Hak Masyarakat Sebagai Konsumen. Aspir J Masal Sos. 2020;11(1):57–72.
3. Agustina T, Teknik F. Kontaminasi Logam Berat Pada Makanan Dan Dampaknya Pada Kesehatan. Teknobuga. 2014;1(1):53–65.
4. Rurut SF, Sumampow DMF, Rotinsulu W. Analisis Konsentrasi TImbal pada Tanaman Kubis (Brassica oleraceae L) di Kota Tomohon. Cocos [Internet]. 2019;
5. Eka Putri W, Naria E, Nurmaini. Analisis Kadar Timbal (Pb) Pada Sayuran Selada dan Kol Yang Dijual di Pasar Kampung Lalang Medan Berdasarkan Jarak Lokasi Berdagang dengan Jalan Raya Tahun 2015. Dep Kesehat Lingkung FKM USU. 2015.
6. Lestari TRP. Keamanan Pangan Sebagai Salah Satu Upaya Perlindungan Hak Masyarakat Sebagai Konsumen. Aspir J Masal Sos. 2020;11(1):57–72.
7. BPS. Kecamatan Selupu Rejang dalam Angka 2021. News.Ge. 2021.
8. Anindityo IC, Wahyuningsih NE, Darundiati YH. Kandungan Logam Berat (Pb dan Hg) pada Sayuran di Desa Kopeng Kabupaten Semarang dan Analisis Risiko Kesehatan Lingkungannya. VISIKES J Kesehat Masy. 2021;20(1).
9. Katipana, D. 'Uji Kandungan Logam Berat Timbal (Pb) Pada Kangkung Air (Ipomea aqutica F) di Kampus Unpatti Poka', *BIOPENDIX: Jurnal Biologi, Pendidikan dan Terapan*, 1(2), 2015. pp. 153–159.
10. Sugiyatmi S. Faktor Risiko Pencemaran Bahan Toksik Boraks Dan Pewarna Pada Makanan Jajanan Tradisional Yang Dijual Di Pasar Pasar Kota Semarang Tahun 2006. Tesis. 2006;1–10.
11. Alwi J, Yasnani Y, Ainurafiq A. Analisis Risiko Kesehatan Lingkungan Akibat Pajanan Timbal (Pb) pada Masyarakat yang Mengonsumsi Kerang Kalandue (Polymesoda erosa) dari Tambak Sekitar Sungai Wanggu dan Muara Teluk Kendari. J Ilm Mhs Kesehat Masy Unsyiah. 2016;1(3):184618.
12. Fibrihirzani H. Hubungan Antara Karakteristik Individu, Orang Tua dan Lingkungan dengan Konsumsi Buah dan Sayur pada Siswa SDN Beji 5 dan 7 Depok. 2012;
13. Juvita Ayu Puspitaloka, Nur Endah Wahyuningsih, B.'Efektivitas Variasi Ketebalan Arang Aktif Tempurung Kelapa dalam Menyerap Kandungan Logam Berat Timbal pada Larutan Pestisida Mengandung Timbal', 6, 2018. pp. 1–23.
14. Birawida A. Penilaian Dan Manajemen Risiko Timbal Di Udara Pada Anak Sekolah Dasar Pesisir Kota Makassar. J Mkmi. 2016;12(1):54–62.
15. Alwi J, Yasnani Y, Ainurafiq A. Analisis Risiko Kesehatan Lingkungan Akibat Pajanan

Timbal (Pb) pada Masyarakat yang Mengonsumsi Kerang Kalandue (Polymesoda erosa) dari Tambak Sekitar Sungai Wanggu dan Muara Teluk Kendari. J Ilm Mhs Kesehat Masy Unsyiah. 2016;1(3):184618.

16. Maddusa, S. S. *et al.* 'Risiko Kesehatan Lingkungan Paparan Logam Berat Pada Ikan Nilem (Ostoechillus vittatus) di Desa Bakan Kecamatan Lolayan Kabupaten Bolaang Mongondow', *Higiene*, 8(1),2022. pp. 1–6.
17. Liono, V. V. *et al.*'200 Analisis Risiko Kesehatan Lingkungan Paparan Logam Berat Arsen (As) pada Masyarakat Sekitar Sungai yang Mengonsumsi Ikan Nilem (Ostoechillus Vittatus) dari Sungai Desa Bakan Kecamatan Lolayan Kabupaten Bolaang Mongondow', 11(2), 2022.pp. 200–206.
18. Raharjo P, Raharjo M, Setiani O. Analisis Risiko Kesehatan dan Kadar Timbal Dalam Darah: (Studi Pada Masyarakat yang Mengkonsumsi Tiram Bakau (Crassostrea gigas) di Sungai Tapak Kecamatan Tugu Kota Semarang). J Kesehat Lingkung Indones. 2018;17(1):9.
19. Widnata Putra IMP, Harsojuwono BA, Lani Triani IG. Hubungan Waktu Penyemprotan Pestisida Sebelum Panen Terhadap Residu Profenofos dan Karakteristik Mutu Sawi Pakcoy (Brassica rapa L). J Rekayasa Dan Manaj Agroindustri. 2018;6(2):158.
20. Ma'rufi, I.'Analisis Risiko Kesehatan Lingkungan (Arkl) Akibat Transportasi Kendaraan Bermotor Di Kota Surabaya', *The 17th FSTPT International Symposium, Jember University*, 2014. pp. 1170–1175.
21. Hapsari, T., Darundiati, Y. H. and Dangiran, H. L. 'Analisis Risiko Kesehatan Lingkungan Kandungan Timbal (Pb) pada Kerang Hijau yang Dikonsumsi Istri Nelayan di Tambak Lorok Semarang', *Jurnal Kesehatan Masyarakat*, 15(2), 2017. pp. 1–23.
22. Sylvia M, Vianne A, D YH, D HL. Analisis Risiko Kesehatan Lingkungan Kandungan Kadmium (Cd) Dalam Ikan Bandeng Di Kawasan Tambak Lorok Semarang. J Kesehat Masy. 2017;5(5):724–32
23. Pratama A. Analisis Risiko Kesehatan Lingkungan Pada Pedagang Sarabba Akibat Pajanan Gas NO2 Di Sepanjang Jalan Sungai Cerekang Kota Makassar. 2021;(2):14–6.
24. Fibrihirzani H. Hubungan Antara Karakteristik Individu, Orang Tua dan Lingkungan dengan Konsumsi Buah dan Sayur pada Siswa SDN Beji 5 dan 7 Depok. 2012;
25. Widnata Putra IMP, Harsojuwono BA, Lani Triani IG. Hubungan Waktu Penyemprotan Pestisida Sebelum Panen Terhadap Residu Profenofos dan Karakteristik Mutu Sawi Pakcoy (Brassica rapa L). J Rekayasa Dan Manaj Agroindustri. 2018;6(2):158.