ORIGINAL ARTICLE

Heavy metals in *cincalok* at Tanjong Kling and Umbai, Melaka

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Abstract:

Heavy metal contamination becomes crucial as it can bio-magnified in human body. This study has been carried out to determine the concentration of heavy metals (lead, cadmium and copper) in *cincalok* samples collected from two different sources and its potential health risk. This cross sectional study was carried out to determine the concentration of heavy metals in *cincalok* and its relation to anthropogenic activities in Malacca Straits. *Cincalok* samples were collected from Tanjong Kling and Umbai, Melaka. Stratified random sampling was applied during sampling which was the samples from the same batch only. Then, the samples were treated based on US EPA method 3050 B for Acid Digestion of sediments, sludges and soils. The samples were then analyzed using the Atomic Absorption Spectrophotometer (AAS, Pin AAcle 900 Perkin Elmer) to determine the concentration of heavy metals in *cincalok.* The analysis showed the highest level of Copper in *cincalok* from both sources, small amount of cadmium and no detection of lead were shown in all samples. The sequence of order of the heavy metals measured is Cu>Cd>Pb. The Target Hazard Quotient (THQ) was low for all heavy metals and shows no potential health risk. There is significant difference for concentration of copper in *cincalok* from both sources. The level of heavy metals Pb, Cd and Cu did not exceed permissible limits by Malaysian Food Act 1983. Consumption of *cincalok* from both sources can be concluded safe as the level of selected heavy metals did not exceed the acceptable food standard limits and with low THQ level.

Keywords: Cincalok, heavy metals, health risk assessment

1. INTRODUCTION

Cincalok or pickled shrimp, is the third most common of the fermented fish products from Malaysia [1]. *Cincalok* production is concentrated in the state of Melaka especially in Tanjong Kling and Umbai. The contamination of heavy metals in sea life like shrimp is a concern. Malaysia is one of the developing countries which has many industries such as oil and gas, petrochemical, fabrication, mining and others. These industries may lead to the production of heavy metals caused by improper management of their wastewater.

Tanjong Kling is located near Port Dickson where oil refinery industries reside, while Umbai is near to Muar river. Muar act as a port for shipyard, route of industrial waste and also an active area for sand mining activities [2]. Muar is also located near high density development and industrial area which have high tendency to emit pollutant. The activities at Malacca Straits also affects the amount of heavy metals in the sea. Health Risk Assessment need to be conducted to identify, control, manage and communicate the risk to the public. Target Hazard Quotient (THQ) is the hazard estimation used to measure health effect due to consumption of contaminated *cincalok*.

2. MATERIALS AND METHODS

2.1 Methodology

The source of the *cincalok* are from Tanjong Kling and Umbai, Melaka (Figure 1) as they are the main shrimp supply for *cincalok* production and there are many anthropogenic activities around the production area. Stratified random sampling was used to select the *cincalok* from specific batch only at the same time from both production areas. Only *cincalok* with sealed bottle packaging ready for sale were sampled.

Cross sectional study was conducted in order to determine the concentration of heavy metals in *cincalok* collected from two different sources. Cross sectional study is normally conducted to anticipate the outcome of interest for a given population, commonly for the purposes of public health planning [3].

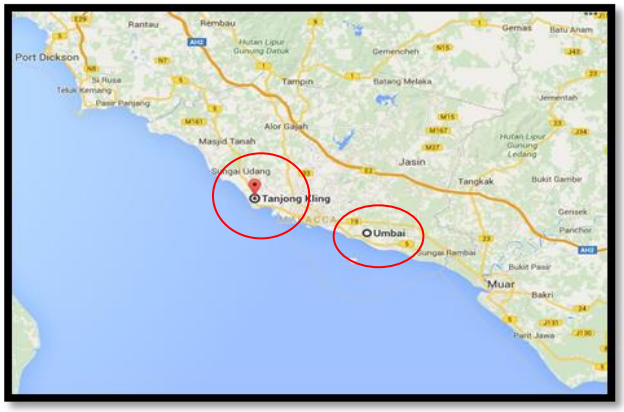

Figure 1. Tanjong Kling and Umbai, Melaka

2.2 Data collection and analysis

Field sampling were carried out by selecting the *cincalok* sample randomly from the two production companies in Tanjung Kling and Umbai. Laboratory works using instrumentation and treatment process also known as Acid Digestion method based on the method by US EPA 3050B, Acid Digestion of sediments, sludges and soils were carried out. By using the US EPA 3050B method, 10g of sample was dried in an oven at 105^0C for 24 hours. Following this, 2 grams of sample were digested using nitric acid and hydrogen peroxide to prepare a sample in the form of aqueous solution. Finally, determination on the concentration of selected heavy metals (Pb, Cd and Cu) was conducted by using Atomic Absorption Spectroscopy (model Perkin Elmer PinAAcle AA800).

3. RESULTS AND DISCUSSION

3.1 Statistical analysis

Result in Table 1, it shows that the p-value for both production area samples were not significant (p-value>0.05). However, the standard deviations of mean for both samples are below than half of the mean concentration of copper. The concentrations of copper from Tanjong Kling were also normally distributed based on their standard deviation of mean.

Table 1. p-value and standard error of means for copper concentration in Umbai and Tanjong Kling

Source of copper	p-value	Standard error of mean
Umbai	0.2	0.17185
Tanjong Kling	0.077	0.27738

Based on Table 2, the concentrations of cadmium were normally distributed for both production area samples. Although the p-value for sample from Tanjong Kling is greater than 0.05, the standard deviation for mean was below than half which follow the rules for significant value. Theconcentration of cadmium for sample from Umbai was significant (p value< 0.05).

Table 2. p-value and standard error of means for cadmium concentration in Umbai and Tanjong Kling

Souce of cadmium	p-value	Standard error of mean
Umbai	0.003	0.0371
Tanjong Kling	0.2	0.03963

The concentration for lead was not detected for both production area samples and therefore the analysis on normality test cannot be conducted.

3.2 Descriptive analysis

Independent t-test analysed by SPSS version 21 were used to obtain the p-value. The p-value for copper from the Levene's test for equality of variance was 0.006. The variances for both production areas were not similar since the p-value is less than 0.05. Then, the p-value for Cadmium is 0.673 which was greater than 0.05. It shows that the variances for both samples were equal. Based on p-value on independent t-test, there was significant difference between concentration of Copper in *cincalok* at Tanjong Kling and Umbai while for Cadmium, there was no significant difference between the concentration in *cincalok* at Tanjong Kling and Umbai based on the p- value on independent t-test.

3.3 Heavy metals concentration perspective according to regulations

Based on Figure 2, the mean concentration of Cadmium from Tanjong Kling was 0.9667 mg/kg compared to the mean concentration of Cadmium from Umbai. The mean concentration of Cadmium in Tanjong Kling also revealed that it almost contravenes the permissible limits set up by the Malaysian Food Act 1983. Other standards that also highlight cadmium limits in fish products include Hong Kong Food Adulteration (Metallic Contaminants) Regulations which is 2 mg/ kg and Food Safety Authority of Ireland (Commission Regulations No 1881/2006 & 629/2008) which is 0.5 mg/kg. Both production area samples contravened the stricter Ireland regulation for heavy metals.

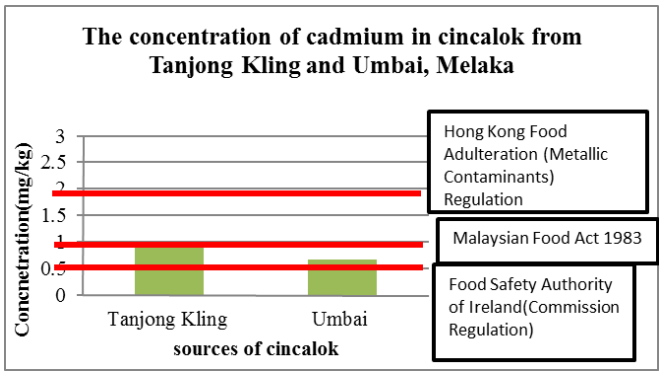

Figure 2. The concentration of Cadmium in *cincalok* from both samples in Tanjong Kling and Umbai, Melaka

Figure 3 shows that the concentration of Copper in *cincalok* from Tanjong Kling was higher compared to the concentration of Copper in *cincalok* from Umbai. The concentration of copper from Tanjong Kling is 13.5187 mg/kg whereas the concentration for copper in *cincalok* from Umbai is 8.6057 mg/kg. The mean concentration from both production areas do not exceed the limits set up by the Malaysian Food Act 1983 and Public Health Thailand 1986 which are 20 mg/kg and 30 mg/kg respectively.

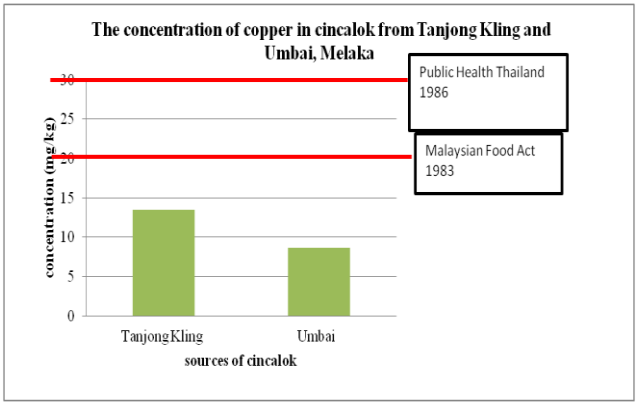

Figure 3. The concentration of copper in *cincalok* from Tanjong Kling and Umbai, Melaka

3.4 Health Risk Assessment (HRA)

Health Risk Assessment was conducted by using the Target Hazard Quotients (THQ), be used to risk estimation equations which can estimate the amounts of heavy metals in food. The equation of target hazard quotients is derived as below [6];

$$THQ = \frac{EF \times ED \times FIR \times C}{RfD \times BW \times AT} \times 10^{-3}$$

Where " THQ = the target hazard quotient;
EF = exposure frequency (365 days/ year);
ED = exposure duration (70 years, average lifetime);
FIR = food ingestion rate (g/ day)
C = heavy metal concentration in cincalok
RfD = oral reference dose (mg/kg/day)
BW = average adult body weight (70 kg)
AT = average exposure time (365 days/year x number of exposure years, assuming 70 years) "

Based on the formula, the THQ value for Cadmium in *cincalok* at Tanjong Kling is 0.1559 mg/kg/day while for Umbai, the THQ value is 0.1077 mg/kg/day. Then, THQ value for copper in *cincalok* at Tanjong Kling is 0.0545mg/kg/day while for Umbai, the THQ value is 0.0349 mg/kg/day.

$$HI = \sum HI = HQ\ Cd + HQ\ Cu + HQ\ Pb$$

The risk of posing adverse health effect is assumed for value which greater than 1.0 is. For value below than 1, the adverse health effects is assumed unlikely to occur. The mean target hazard quotient values for Cu metals is greater than 1 while for Pb and Cd, the target hazard Quotient is below than 1 [6]. From this study, the Hazard Index is about 0.2104 for samples in Tanjong Kling and 0.1426 for sample in Umbai, Melaka. This really shows the Hazard Index of samples from Tanjong Kling is high but they do not pose any adverse health effect.

The process of making *cincalok* is similar to *belacan* (shrimp paste) which requires a lot of tiny shrimp also known as *geragau* (*Acetes* sp). Most of the shrimp caught was used for making *belacan* rather than *cincalok* as the demand for *belacan* is higher [1]. The population of *geragau* is seasonal in nature and annual peak catch was observed in the month of October to December where the east-west monsoon occurs [4]. Heavy metals may affect fermentation process and in other situation, fermentation may decrease the amounts of heavy metals in it. Toxic effect of heavy metals like chromium, cadmium and nickel is attributable to the disruption of enzyme function and structure by binding of the metal ions with thiol and other groups on protein molecules or by replacing naturally occurring metals in enzyme prosthetic groups [8]. The severity of heavy metal inhibition also depends on the solubility, ionic form, species and its biochemical reactions. The high content of histamine which may cause allergy reaction can be due to poor handling, processing, and storage conditions of *cincalok*.

4. CONCLUSION

Heavy metals such as arsenic, lead, cadmium, mercury and others can be naturally found in certain foods as these metals are found in the air, water and soil. At high levels, these metals can be toxic, but eliminating them entirely from the food supply is not always possible. This study has initiated an assessment to see if the local favourite food such as *cincalok* pose heavy metal concern especially due to the anthropogenic activities occurring from the supply area. Assessment of heavy metals in food needs to be conducted continuously and periodically as the number of population and demand of food increase. There are growing research interest on heavy metal compound found in traditional food preparation such as dried squid from the same supply area

[9]. The handling, processing and storage of *cincalok* should also be observed to reduce the risk of physical and bacterial contamination. This local street food may be highly vulnerable to airborne pollutant deposition during processing as well [10].

The industrial activity near Tanjong Kling needs to be monitored to prevent illegal release to the water bodies that may end up in the food chain. Periodical monitoring on heavy metal contamination should in place to keep the food supply safe. Although the process of making *cincalok* can be replaced with fresh water shrimp instead of shrimp from seawater, the quality especially the unique taste may be affected. Furthermore, study should be done on the different processes of making *cincalok*. There might be conventional method and traditional method to make *cincalok* and types of preservatives that may be improved to increase the authentication and tastiness of the local food.

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